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FOR

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The Extinct Mammalia of the Valley of Mexico. By E. D. Cope.

(Read before the American Philosophical Society, May 16, 1884.)

The following study is based primarily on an examination of the specimens contained in the Museum Nacional of Mexico, which I was permitted to make through the kindness of the Director of the Departments of Geology and Mineralogy, Professor Mariano Barcena. Through the mediation of the same gentleman, I obtained permission from Professor Antonio Castillo, Director of the School of Mines, to examine the corresponding material preserved in the fine museum of that institution. The knowledge derived from the study of the latter, reinforced the results I obtained from the study of the specimens of the Museum Nacional, so as to enable me to reach definite conclusions as to the definitions of various species which are represented in both collections. I wish to record the obligations under which I have been laid by both of these distinguished gentlemen. I have, through their aid, been enabled to make a comparison between the pliocene fauna of Mexico, and that of Buenos Ayres, and that of Oregon. The species of the Pampean fauna contained in my private collection, are those exhibited by Messrs. Ameghino, Larroque and Brachet, at the Exposition of Paris of 1878. My Oregon material is derived from the explorations of my parties under Messrs. Sternberg and Duncan, and those of Professor Thomas Condon of the University of Oregon, who kindly lent me his collection.

The collections of the museums of the City of Mexico, above mentioned, are derived from the locality Tequixquiac, and the specimens referred to in the following pages are to be understood as having been derived from that locality unless otherwise stated. Tequixquiac is situated on the northern edge of the valley of Mexico, north of the City of Mexico and the town of Zimpango, and east of the gorge of Nochistongo.

GLYPTODON Owen.

GLYPTODON, sp. indet.

A nearly complete carapace of this remarkable animal is mounted in the Museum Nacional, and a second, nearly as well preserved, is in the Museum of the School of Mines. Jaws and teeth occur in the latter museum. The discovery of this genus at this extreme northern locality is due to Dr. Antonio Castillo. It was first announced by Dr. Mariano Barcena in the Revista Cientifica of Mexico, 1882, I, p. 8. The extension of this far southern genus to the latitude of Mexico during the Pliocene (Pampean) epoch, is entirely consistent with the further distribution of the great sloths and llamas to the United States at the same time.

DIBELODON Cope.

Mastodon pars, auctorum.

Various attempts have been made to define as genera groups of species which are included within the limits of the genus Mastodon of authors. The first new name, Tetracaulodon, was introduced by Dr. Godman, who saw in the mandibular tusks of some individuals of the *Mastodon americanus* Cuv., ground of its separation from the genus Mastodon, in which he believed those teeth to be wanting. This division was adopted by Dr. Grant and others, but has not been generally allowed. The next division was that proposed by Dr. Falconer, who, however, did not employ the names proposed by him in more than a subgeneric sense. He distinguished two series in the genus Mastodon. In one of these, the P-m. 3, and the Ms. 1 and 2 present three transverse crests, while in the other division these teeth present four such crests. To these divisions he gave the names of Trilophodon and Tetralophodon respectively. The third attempt at division is that of Herr Vacek, who gives names to the two divisions of the genus in which the cross-crests are composed of tubercles or continuous ridges. These divisions he calls Bunolophodon and Zygolophodon respectively.*

I will refer to these divisions in reversed order. Those proposed by Vacek cannot be regarded as genera, and their author did not use them as such. The tubercular crest passes into the straight crest by insensible stages. The divisions proposed by Falconer are more distinct, but not sufficiently so to represent genera. This may be understood by reference to the second lower molar of the *Mastodon augustidens*, which is, in some individuals, three crested, and in others four crested. Some other species present the same difficulty. On this point I quote the remarks of Dr. Lydekker:† "The foregoing survey of such a large series of Mastodon molars has led to the conclusion that the very regular ridge formula given by Falconer will not always hold good in regard to the true molars,

* Vacek, Ueber Oesterreichische Mastodonten. Abh. der K. K. Geolog. Reichanstalt, vii, Heft iv, Wien, 1877, p. 45.

† Geological Survey of India, Series x, Vol. i, pt. v, 1880, p. 256.

though in the Indian species, at all events, it appears to be always constant in the milk-molars. We have seen that there is a tendency in the true molars of some of the Trilophodons (*M. falconeri*) to develop the talon into a fourth ridge, and in the Tetralophodons (*M. latidens* and *M. sivalensis*), a similar talon is developed into a fifth ridge, in the intermediate true molars." *M. humboldtii* Cuv. (*M. andium* Falc.*) shows a small fourth crest on the second true molar, according to Falconer.†

The lower incisor teeth, on which Godman relied for the definition of his genus Tetracaulodon, were shown by Harlan, not to be constantly present in the *Mastodon americanus*. In fact, no adult specimen has been described in which two inferior incisors are present. The single one observed is very rarely found in adults, being a character more frequently found in the young. It is in this species a remnant of a character elsewhere constant, which does not disappear quite so soon as the teeth of the whalebone whale, and superior incisors of the ruminant. But it is otherwise with other species referred to Mastodon. No specimens of the *Mastodontes angustidens, productus* and *longirostris*, are recorded, in which two inferior incisors are not present. For this reason the first and last-named were placed by Grant and others in the genus Tetracaulodon. Unfortunately this name was applied by its author to the *M. americanus* only, a species which cannot enter the genus furnished with a pair of persistent inferior incisors. It is also the type of Cuvier's Mastodon.‡ It thus unavoidably becomes a synonym of the latter.

There is no doubt that the presence of a pair of persistent inferior incisors defines a genus as distinct from one in which there is not a pair of permanent inferior incisors. I agree, therefore, with Grant and others, in separating the Mastodons which present this character from the genus Mastodon, under another generic head. I believe, also, that the presence or absence of a band of enamel on the superior incisors furnishes ground for the recognition of distinct generic groups, and would be so used in any other division of the Mammalia. It is often asked why it is necessary to multiply generic names on such grounds. My answer is simply an expression of the law governing the case, based on the supposition that when the species of animals and plants come to be fully known, the genetic series will be found to be uninterrupted, excepting by the presence or absence of characters which appear or disappear during the growth of a set of individuals, which we on this account call a species, or refer to a genus. The difference in the two cases consists in this: In the case of species, the characters are numerous and are matters of proportion, size, color, texture, etc., while in the case of the genus the character is single, and marks one step in the serial chain of structural modifications. In the case of the genus there is an actual addition or subtraction of some distinct

* Palæontological Memoirs of Falconer, i, p. 100, pl. 8.

† Loc. cit., ii, p. 15.

‡ Ossemens Fossiles, ii, p. 252, Ed. 1834: "Ann. Mus., 1806, viii, 272," teste Leidy.

part or piece of the organism.* If now we fail to notice these points or steps, we must abolish all genera. If we define some and fail to define others, our practice ceases to have the uniformity of a law, and we abandon the basis of scientific order.† One point, however, must be insisted on. In order that a character be usable for any purpose of definition, it *must define*. That is, *it must belong to all the individuals referred to the* species, genus, etc., defined, and must not be present in some individuals and wanting in others of those supposed to be defined by it. This being the case, adult animals only can be used for definition, as characters, especially generic, are added from time to time up to maturity. Sometimes only one sex can be considered, since the adult characters are in certain cases never reached by one sex or the other. This is often the case with insects. Moreover, some latitude for exceptional variations must be allowed. Thus, the exceptional absence of the last molar in a dog does not invalidate the definition of the genus Canis, M. $\frac{2}{3}$.

Of course, if all specimens of animals could be found, the definitions would all, or nearly all, be invalidated. But it is safe to assume that all the intermediate forms will not be found, so that the definitions of species will represent the state of our knowledge, and the results of the operations of nature in the preservation of individuals.

The case is somewhat different with regard to generic characters. As these involve the addition or subtraction of some part, having definite dimensions, it is quite possible to say when the latter is present or absent. Characters of this kind present the appearance of abruptness of transition, to which I have referred in my paper "On the Origin of Genera," and which gave rise to the formulation, by Professor Hyatt and myself, of the "laws of acceleration and retardation." When such change prevails throughout all the individuals of one or more species, a new genus has its origin. As a matter of fact, the creation of generic modifications has been exhibited, in the history of life, by many individuals nearly contemporaneously. As the change involves *but one character*, it offers a better opportunity for the formulization of the laws of evolution, than in the case of specific characters, which are more numerous.

The three genera of Elephantidæ, of which mention has been made above, will then be defined as follows:

Mastodon Cuv. Superior incisors without enamel band; inferior incisors wanting. Type *M. americanus.*

Dibelodon Cope. Superior incisors with enamel band; inferior incisors wanting. Type *D. shepardi.*

Tetrabelodon Cope. Superior incisors with enamel band; inferior incisors present in the male at least. Type *T. angustidens.*

To the genus Mastodon must be referred the following species. For

* See "Origin of Genera," Proc. Acad. Philada., 1869, where this point is discussed.

† American Naturalist, 1884, July, p.

the dental characters of the Indian species I am indebted to Messrs. Falconer and Lydekker :

Mastodon americanus Cuv., N. America.
" *?borsoni* Hays, E. and S. Europe.
" *mirificus* Leidy, N. America.
" *falconeri* Lydd., India.
" *arvernensis* C. & J., Europe.
" *sivalensis* Falc., India.
" *latidens* Clift., India.
Dibelodon shepardi Leidy, California, Mexico.
" *tropicus* Cope, Tropical America.
" *humboldtii* Cuv., South America.
Tetrabelodon angustidens Cuv., India, Europe, N. America.
" *andium* Cuv., S. America, Mexico.
" *productus* Cope, SW. N. America.
" *euhypodon** Cope, N. America.
" *pentelici* Gaudry, SE. Europe.
" *perimensis* Falc., India.
" *pandionis* Falc., India.
" *turicensis*† Schinz, Europe.
" *campester* Cope, N. America.
" *longirostris* Kaup, Europe.

The condition of the inferior incisors is unknown in the *Mastodon atticus* Wagner, and *M. serridens* Cope, and *M. proavus* Cope ; and in some of the above species the presence of an enamel band on the superior incisors has not been established.

I may add that I do not perceive how the so-called genus Stegodon can be distinguished, as at present, by the number of crests of the intermediate molars, and by the presence of cementum. It will probably be necessary to look for other characters in order to sustain it.

DIBELODON SHEPARDI Leidy.

Mastodon shepardi Leidy, Proceedings Academy Philadelphia, 1870, p. 98 ; 1872, p. 142.

Mastodon obscurus Leidy part, Report U. S. Geol. Survey Terrs. I, p. 330, Plate xxi.

This species was originally proposed on the evidence of a last inferior molar tooth from Contra Costa county, California, and a part of a superior tusk from Stanislaus county in the same State. Dr. Leidy subsequently abandoned the species. I however revived it in a synoptic table of the species of North American Mastodons in 1884. ‡

The fossils of the Museum Nacional of Mexico, examined by me, included

* American Naturalist, 1884, p. 525.

† Von Meyer is my authority for the presence of mandibular tusks in this species, = *M. virgatidens* Meyer.

‡ American Naturalist, 1884, p. 524.

a well-preserved lower jaw of a Mastodon, which presents both rami, and both the last true molars, and the entire symphysis. In the collection of the Ecole des Mines I saw a palate with the second and third true molars of both sides in place, and the superior incisor teeth, or tusks. Other fragments of jaws, with numerous isolated molars, were seen in these collections and in that of the college of the city of Toluca.*

From these specimens it is clear that the high valleys of Mexico were inhabited by a trilophodont mastodon, with a short decurved toothless symphysis like that of the *Elephas primigenius*, and with a band of enamel on the superior incisor tusks. The molars have the characters of those of the *Mastodon andium* of authors, and are of about the same size. The cross-crests are divided at the middle line only, and one half wears into a trefoil, while the other half wears into an oval, transverse to the long axis of the crown. The unworn crests are obtuse and not serrate; and there are no accessory tubercles besides those forming the lateral lobes of the trefoils. The size of the ramus and of the teeth is about that of the *M. angustidens*, and smaller than that of the *M. humboldtii*. The last inferior and last superior molars have but four cross-crests and a small heel. This I verified on several specimens.

A comparison of this species with those described, yields the following results: In the character of its molars it is identical with the *M. andium*, and differs from the *M. humboldtii* in the characters which distinguish the two species, as pointed out by Gervais.† That is, only one-half of each cross-crest wears into a trefoil, and the size is inferior. But it cannot be identified with the *Tetrabelodon andium*, because, according to Falconer,‡ that species possesses a long massive deflected beak containing an incisor tooth.‖ It is true that the specimen figured by Laurillard in D'Orbigny's voyage dans l'Amerique Meridionale, Pl. x, does not display a long beak and tusk, although the symphysis is much more pronounced than in the present species. But that plate is made from a drawing, and may thus be of doubtful authority. If correct, it may represent the female, or, as Falconer suggests, the young of the *T. andium*. The last inferior molar figured by Dr. Leidy, l. c., and formerly referred to a species under the name of *Mastodon shepardi*, has the character of the corresponding tooth of the Mexican species under consideration. The plate does not, however, represent the specimen satisfactorily in one respect. The trefoils are not sufficiently distinct, on account of the faint representation of their basal lobes. These nearly block up the cross valley, a fact not to be derived from an examination of the plate, but which is clearly seen in a cast preserved in the museum of the Philadelphia Academy of Natural Sciences.

* For the opportunity of examining the museum of this Institution I am much indebted to its President, Dr. Villada.

† In Castelnau's Expedition, 1855; Recherches sur les Mammiferes Fossiles de l'Amerique Meridionale, p. 14.

‡ Palæontological Memoirs, ii, pp. 226, 274.

‖ The lower jaw figured by Falconer, Mem. i, p. 100, from Buenos Ayres, as *M. audium* is clearly *M. humboldtii*.

This specimen also agrees with those in the Mexican museums in the small number of crests on the last inferior molar: four with a short rudimental heel. Another specimen of apparently the same species is described and figured by Leidy as having been brought from Tambla, Honduras.* This tooth is apparently anomalous in the contraction of the third. cross-crest.

The range of this species may then be given as extending from California to the valley of Mexico, inclusive.

A species apparently allied to the *Dibelodon shepardi* is the *Mastodon serridens* Cope,† of which the typical specimen was brought from southwestern Texas. Premolar teeth of the same type were shown me by Professor Castillo, in the museum of the School of Mines. These came from a lignitic bed at Tehuichila, in the State of Morelos, of Loup Fork age. This epoch is indicated by the presence of the genera Protohippus and Hippotherium. The sharp, serrate edges of the crests distinguish the molar teeth from those of the *D. shepardi*, and as the species probably came from different horizons, they are probably distinct. A premolar mingled with those of *D. shepardi*, from the valley of Toluca, much resembles that of the *M. serridens*.

DIBELODON TROPICUS Cope, sp. nov.

Mastodon humboldtii? VonMeyer Palæontographica, 1867, Studien ueber das genus Mastodon, p. 64, Pl. vi. *Mastodon andium* Leidy, Proceedings Academy Philada., 1876, p. 38.

A second species of Dibelodon inhabited the valley of Mexico, of larger size than the *D. shepardi*, and differing somewhat in the dentition. Von Meyer describes and figures a ramus of a lower jaw, l. c., brought by Herr Uhde from Mexico, which has, according to Von Meyer, no mandibular tusk, and probably a short elephantine symphysis. A very similar ramus, containing the last molar tooth, was presented to the Philadelphia Academy of Natural Sciences by Dr. Isaac Coates, who obtained it from Tarrapota, on the Huallaga river, in Eastern Peru. The extremity of the symphysis of this specimen is broken away, but enough remains to show that it was probably short, and that there was no inferior incisor.

Reference to Von Meyer's figure shows that the last inferior molar has five well-developed cross-crests and a heel. The Peruvian specimen has the same character, the fifth cross-crest a very little more contracted than in Von Meyer's plate. Dr. Leidy describes the specimen as having four transverse ridges, besides a strong tubercular talon. But it seems to me that the talon is of such size as to be properly included in the cross-crests. On the same principle one might say that the *D. shepardi* has three cross-crests and a strong talon, as it has one less cross-crest than the *D. tropicus*. The additional cross-crest, and the superior size, distinguish this form as a species from the *D. shepardi*. Von Meyer perceived these differences, and referred his specimen to the *D. humboldtii*. I am fortunately able to

* Extinct Mammalia Dakota and Nebraska, Pl. xxvii, fig. 14.

† American Naturalist, 1884, p. 524.

make a comparison of his plate and the Peruvian jaw, with a well preserved jaw of the *D. humboldtii*, with perfect last molar and symphysis, from Buenos Ayres, in my collection. I am able fully to substantiate the characters already pointed out by Gervais, and to prove that the cross-crests of the molars form double trefoils, while those of the *D. tropicus* are like those of *D. shepardi* and the *Tetrabelodon andium*.

The species last named is said by Falconer (loc. sup. cit.) to occur in Mexico, and speaks of having seen a well preserved lower jaw from the State of Tlaxcala. I have not met with it.

The *Mastodon americanus* has not yet been found in Mexico. The most southern localities for the species known to me are Southern California, and near San Antonio, Texas. From the former region I possess a ramus with the last molar, presented to me by Mr. Scupham, of San Francisco; the other specimen was obtained from Mr. G. W. Marnock, of Helotes, near San Antonio, Texas.

ELEPHAS Linn.

ELEPHAS PRIMIGENIUS Blum.

This species, of both the thick and thin plated varieties, was once very abundant in Mexico. I have received a series of teeth from Candela, in the State of Coahuila, from Dr. Caspar Butcher, through my friend Dr. Persifor Frazer; and Von Meyer has pointed out the occurrence of its remains in the valley of Mexico. The museums of Mexico contain very numerous portions of skeletons of this species, which prove that it was far more abundant than the species of Mastodon. Up to this time this locality is the southern known limit of its distribution on the American continent.

APHELOPS Cope.

APHELOPS, sp. *Aphelops ?fossiger* Cope. Proceedings Academy Philadelphia, 1883, p. 301.

The right half of the mandible, with part of the symphysis of a rhinoceros, was found in the valley of Toluca, sixty miles west from the city of Mexico, and Dr. Barcena sent me a photograph of it a year ago. I published a notice of it as above cited, in connection with remarks on a rhinoceros skull which I obtained on one of the heads of the Gila river in New Mexico. On my recent visit to the College of Toluca, I had, through the kindness of Professor Villada, the opportunity of examining the jaw. Its characters do not differ much from those of the *Aphelops fossiger* Cope. It is considerably smaller, and has a very short diastema, but not shorter than in some jaws of the *A. fossiger*. The dimensions are as follows:

Measurements.	M.
Length of ramus from base of canine	.400
" " dental series with canine, less M. iii	.235
" " molar series, less M. iii	.200
" " true molars, less M. iii	.105

Measurements.	M.
Diameter of canine (transverse)	.027
" of P-m. ii	.007
Depth of ramus at P-m. iii	.070
" " " at M. i	.085
" " " at front of M. iii	.090

The matrix in which this jaw was found, is much like the Upper Pliocene material of Tequixquiac. It is therefore of probably later age than the true *Aphelops fossiger*, which is a characteristic Loup Fork species. Leidy describes (Extinct Fauna of Dakota and Nebraska, p. 230) a rhinocerus, probably an Aphelops, from California, under the name of *R. hesperius.* It is smaller than the Toluca specimen, but has a considerably longer diastema. Its geological horizon is uncertain.

I mention here that rhinoceroses, probably of the genus Aphelops, apparently existed in North America during the Pliocene period. Bones of a species having resemblances to the *A. fossiger* have been sent me by my assistant, George C. Duncan, from the Equus beds of the eastern part of the Oregon desert. The genus has been hitherto supposed not to ascend higher than the Loup Fork, or Upper Miocene beds. These bones are accompanied by teeth of a peculiar Hippotherium unlike those of any species of the genus known to me from the Loup Fork Miocene.

EQUUS Linn.

The remains of horses are very abundant in the valley of Mexico,* and represent four species. In the determination of these species it has become necessary to compare them with those hitherto found in North and South America. In making this comparison I exclude the species of Hippidium, which are all American, and whose molar teeth are easily distinguished by the equality in size of the internal columns; resembling in this respect the genus Protohippus.

When the species of the genus Equus differ in the characters of their superior molar teeth, the diversity is to be seen in the size and form of the anterior internal column. The anteroposterior diameter of this column, as well as the integrity or emargination of the internal border of its section, varies according to the species. The infolding or the borders of the lakes has a value, but a less constant one. The *Equus caballus* differs from all of the American extinct species, where the corresponding parts are preserved, in the great elongation of the face, which is expressed in the greater lengths of the diastemata anterior and posterior to the canine tooth in both jaws. Other characters may be observed in the relative lengths of the limb bones, the form of the occiput, etc. It has been shown by Leidy, Rütimeyer and others, that it is not always practicable to distinguish the species of horses by their teeth alone. A glance at Owen's

* This fact has already been made known by Von Meyer, Palæontographica, 1867, p. 70, and Owen, Transactions of the Royal Society, London, 1869.

plates of the dentition of the existing species of Equus*, shows the truth of this statement. Among the extinct species of Equus the range of variation is greater.

The following attempt at a discrimination of the species known to me, or so fully described as to be well known, must necessarily be regarded as provisional, until the skeletons are more fully recovered. American extinct species only are introduced :

I. Long diameter of anterior internal lobe of superior molars not greater than one third the long diameter of the crown.

Borders of lakes crenate ; internal anterior lobe notched on the inner side so as to be bilobate ; crowns a little curved ; large......*E. crenidens.*

II. Long diameter of anterior internal lobe more than one-third and not more than one-half the anteroposterior diameter of the crown.

a Crowns more or less curved.

Crowns wider than, or as wide as long ; enamel edges little folded........ *E. curvidens.*

aa Crowns straight or nearly so.

β Diastemata longer.

Crowns nearly square, enamel not very complex ; no facial fossa ; maxillary bone produced much beyond M. iii..................*E. caballus.*

ββ Diastemata shorter.

γ No facial fossa.

Crowns nearly square ; enamel not very complex ; maxillary bone little produced behind last molar ; smaller.................................. *E. hemionus ; E. burchelli ; E. quagga ; E. zebra ; E. asinus.*

Crowns longer than wide on face ; enamel little complicated ; face and maxillary unknown ; large..........................*E. occidentalis.*

Crowns square ; enamel more folded than in other species ; face and maxillary unknown ; large..................................*E. major.*

γ A facial fossa.

Crowns nearly square ; enamel less complex ; maxillary short posteriorly ; smaller..*E. andium.*

III. Long diameter of anterior inner lobe more than half that of crown of molar teeth.

Crowns square ; enamel little complex (in Mexican specimens) ; diastemata and maxillary behind shorter ; no facial fossa ; large...*E. excelsus.*

Crowns square ; enamel little complex ; smallest species......*E. barcenai.*

In using the above table it must be noted that gradations in the diameter of the anterior internal column (or lobe) exist, not only between individuals of the same species, but between different teeth in the same jaw. This diameter is always greatest in the last superior molar, and the characters of this tooth are such that they cannot be used in connection with the above table.

* Philosophical Transactions, 1869.

Before describing the Mexican species I make some notes on the others embraced in the above list:

Equus curvidens Owen. Of eight superior molar teeth from Buenos Ayres in my collection, two second premolars are perfectly straight, while the third true molar is the most curved. The other teeth exhibit different degrees of curvature. The area of the anterior internal column is not so flat on the inner side in any of them as in Owen's Plate (Voyage of the *Beagle*, Vol. i). My teeth have also a rather greater transverse diameter than Professor Owen's type.

Equus caballus L. The common horse differs from all of the extinct species of the genus from American localities where the muzzle is known, in the greater length of the latter, with its diastemata, of both jaws, and in the greater prolongation of the maxillary bone posterior to the last true molar. Appropriately to the anterior position of the molar series, the facial ridge commences above the middle of the first true molar. In an *Equus quagga* in my possession the ridge commences above the middle of the last premolar. The basioccipital bone is more compressed than in any species of the genus known to me.

Equus occidentalis Leidy. This species is represented in my collections by at least one hundred individuals, some of which have been lent me by my friend Professor Thomas Condon of the University of Oregon. They are nearly all derived from the Equus beds of the Oregon desert. Unfortunately there is no perfect skull. A few specimens from the same region I refer to the *Equus excelsus*, but as these are comparatively rare, I am safe in referring most of the bones to the other species. In these I find the following characters to separate the species from the *Equus caballus*: (1) The basioccipital bone is not compressed, and besides its inferior lateral angles it has a pair of lateral angles, one proceeding forwards from the inferior border of each *foramen condyloideum anterius*. (2) The fossa enclosed between the paroccipital process and the basioccipital, is deeper, and has a raised border in front which separates it strongly from the plane of the petrous bone. This is not found in *E. caballus*. I verify it in three separate occipital bones of the *E. occidentalis*. (3) The astragalus and other bones of the feet are smaller than in *E. caballus*; the first named intermediate in size between that of the horse and that of the quagga. The cannon bones, when of the same length, are more slender. (4) The inferior canine issues in direct contact with the last incisor, without the diastema seen in the horse; and the incisive arc is narrower and more produced. The symphysis is elongated not only forwards, but also posteriorly. The mental foramen is anterior to the bifurcation of the rami in *E. occidentalis*, posterior to it in *E. caballus*.

Equus major Dekay. Dr. Leidy leads us to infer (Report U. S. Geol. Survey Terrs., Vol. i, p. 244), that this species differs from the *E. occidentalis*, in the generally greater complication of the enamel folds. This I find to be the case in specimens from the Fish House, in the brick clay, near Philadelphia, and from the Big Bone Lick, Kentucky. Leidy

figures similar specimens from various parts of the Eastern and Southern States.

EQUUS CRENIDENS Cope, sp. nov.

This large species of true horse is represented by molar teeth and fragments of jaws belonging to two individuals preserved in the Museo Nacional of Mexico, and to two others preserved in the Escuela des Minas. The typical specimen includes the three premolars of the upper jaw of an adult in perfect preservation.

The species is primarily distinguished by the close and strong wrinkling of the enamel border of the lakes of the superior molar teeth. This wrinkling, or vertical plication, reminds one of what is seen in the *Elephas indicus*. This wrinkling is not found in the enamel edges which border the interior crescents on the inner side, nor in those bordering the internal lobes or columns. The borders of the lakes are not folded in the complex loops seen in *Equus major* Dek., but have the plainer looping seen in the *Equus tau* Ow. The grinding faces are nearly square. That of the second premolar is a rather shortened triangle, and less produced anteriorly than in the *E. tau*. The crowns of the third and fourth premolars are long and slightly curved.

The measurements show that this is one of the larger species of horse.

Measurements.

		M.
Diameters of P-m. ii	anteroposterior	.0430
	transverse	.0305
Diameters of P-m. iii	anteroposterior	.0335
	transverse	.0340
Diameters of P-m. iv	anteroposterior	.0310
	transverse	.0350

The crimping of the enamel of the lakes distinguishes this species from the others of the genus.

From Tequixquiac.

EQUUS TAU Owen. Philosophical Transactions of the Royal Society, 1869; p. 565; pl. lxi; fig. 4.

Of this species there are preserved in the Museum Nacional five superior molars, some of which belong apparently to one individual. In the Escuela des Minas, the series is a fine one. There are two skulls lacking the occiput; one skull lacking the occiput and muzzle; parts of both maxillary bones with teeth, of one skull; and a single maxillary bone with teeth, of a fifth skull. The specimen mentioned under the second head, has teeth and palate preserved, as in the figure given by Owen of his *Equus conversidens*, and I suspect it was from this specimen that the photograph was taken from which Professor Owen's figure and plate were made. It is possible that his figure and description of the *Equus tau* were made from one of the maxillary bones mentioned under head three. I am not able to perceive the specific differences between these specimens. The character displayed

by Owen's *E. conversidens*, on which he relied to distinguish the species, may be the result of distortion. The maxillary bones of the type are loose and may be made to assume different angles to each other. The last superior molar is represented as unusually short by Owen. This appearance could be produced by the oblique angle of the aperture of the camera in photographing, due to its too anterior position. Be that as it may, I could detect no specific differences between the seven or eight specimens I examined.

The *Equus tau* is an average horse in all respects, presenting no very tangible characters by which to distinguish it from the existing species of the *E. asinus* and *E. zebra* group, so far as the parts which I examined go. It has the internal anterior column of the superior molar always less in diameter than half that of the crown of the tooth, and not characterized by any marked peculiarity. The borders of the lakes have an entering loop on each end of the inner border; of these the adjacent ones are well marked, and the remote ones little marked. External to the adjacent loops the borders of the lakes are a little crenate. There is a small internal median loop of the internal enamel border at the notch. The crowns of the teeth are a little wider than long, and they are not curved. The palate notch reaches as far forwards as the posterior border of the second true molar, and the palatal foramen is opposite the front of the third true molar. The latter tooth is a little longer than the other true molars. The second premolar is short and robust. The diastemata are rather short, as can be seen by the appended measurements.

Measurements.		M.
No. 1. Escuela des Minas.		
Length of precanine diastema		.020
Length of postcanine diastema		.074
Length of molar series		.151
No. 2. Museum Nacional.		
Diameters of P-m. ii	anteroposterior	.030
	transverse	.024
Diameters of ?P-m. iii	anteroposterior	.024
	transverse	.027
Diameter of ?P-m. iv	anteroposterior	.025
	transverse	.028

This species differs from the *Equus andium* Wagn., so fully described by Branco,* in the absence of a facial fossa. From *Equus caballus* it differs in the short diastemata, and the little posterior production of the maxillary bone. How it differs from the species of the *asinus* section I do not yet know.

Equus excelsus Leidy, Extinct Mammalia Dakota and Nebraska, 1869, p. 266; pl. xxi, fig. 31.

*In Dames and Kayser Palæontologische Abhandlungen, 1883, p. 110, Dr. Branco furnishes reasons for believing that the *E. argentinus* Burm. is the same species

A portion of a left maxillary bone supporting the true molars of a horse from the Oregon desert, received from Professor Condon, resembles closely the type specimen from Nebraska described by Leidy as above. Two skulls, in the two museums of Mexico already referred to, present the same dental characters. In identifying the Mexican with the Oregon and Nebraska horses, I wish to be understood as making a provisional arrangement only, for unfortunately the cranium of the North American horse with this dentition is yet unknown. The uncertainty attending a dental identification being admitted, I proceed to the description.

This species differs from the others, whose remains have been found in the valley of Mexico, in the elongate and flattened form of the lobe formed by the section of the anterior internal column of the superior molar. This long diameter generally exceeds the half of that of the crown of the tooth by one-eighth the latter, and is rarely so short as one half of the same. The loops of the lakes are few, including only one near the posterior borders near the internal side and one on the anterior border of the posterior lake. There is generally a little loop at the notch between the two internal lobes. Crowns straight, second superior premolar elongate and acute.

One of the crania is complete, lacking only the lower jaw, and the two third true molars. The other lacks all posterior to the palatal notch. From the former I derive the following characters:

The apex of the nasal bones is above the superior canine tooth. The posterior border of the nares marks the middle of the anterior column of the third premolar. The infraorbital foramen is above the posterior edge of the second column of the fourth premolar. There are two notches on the anterior part of the superciliary border; and there is a short exostosis on each side of the front, in line with the supraorbital border, in front of the preorbital border.

Measurements.		M.
Length from superior edge of foramen magnum to incisive border		.565
From posterior nares to incisive border		.300
Interorbital width		.166
Length of series of molar teeth		.191
" precanine diastema		.022
" postcanine "		.056
Width of palate at third incisors		.092
" " canines, inclusive		.075
Diameters P-m. ii	anteroposterior	.0425
	transverse	.0275
Diameters P-m. iii	anteroposterior	.032
	transverse	.034
Diameters M. iii	anteroposterior	.0335
	transverse	.029

The internal anterior column of the superior molars is longer and flatter than in the specimens of the North American horse, but I do not feel at liberty to propose a new specific name for the Mexican animal. The absence of facial fossa and short diastemata throw it into the series of the asses. From all these the large flat internal column distinguishes it. The presence of the loop at the notch of the internal border in the Mexican specimens distinguish them from Leidy's type and from one of Condon's specimens. A second one of the latter has a small loop at the point in question. The absence of this loop is given by Leidy as characteristic of the *E. occidentalis*, but only a small proportion of my specimens of that species are without it.

The Mexican specimens are from Tequixquiac.

EQUUS BARCENÆI Cope, sp. nov.

Two superior molars represent this species in the Museum Nacional, and two superior molars in the Escuela des Minas. A skull lacking all in front of the orbits inclusive, in the latter museum, probably belongs to the same species.

This horse is distinguished from all the others here mentioned or described by its small size. In the characters of its superior molars it is like the *Equus excelsus*. The anterior internal column is flat, and its anteroposterior diameter is five-eighths that of the crown of the tooth. The prism is straight. The lakes have the margin but little looped; the posterior notch of the anterior lake is trebled or triplex. The grinding face of the crown of the third superior molar is a little longer than the others.

Measurements.		M.
Diameters of molar No. I	anteroposterior	.0215
	transverse	.0280
Diameters of molar No. II	anteroposterior	.022
	transverse	.022

From Tequixquiac.

I have dedicated this species to my distinguished friend Mariano de la Barcena, Professor of Geology in the National Museum and Director of the Meteorological Observatory of the City of Mexico.

PLATYGONUS Leconte.

PLATYGONUS ? COMPRESSUS Leconte.

A portion of the mandibular ramus of a species of peccary, apparently the above, was found at Tequixquiac, and is preserved in the museum of the College of Guanajuato. Dr. Alfredo Dugés, the distinguished professor in the college, called my attention to the specimen, and gave me a cast of it. Its dimensions are similar to those of North American individuals, as follows:

Measurements.		M.
Diameters of M. i	anteroposterior	.0145
	transverse	.012

Measurements.		M.
Diameters of M. ii	anteroposterior	.017
	transverse	.014

HOLOMENISCUS, gen. nov.

Under the head of this genus I give a synopsis of the results of my study of the extinct Camelidæ of the American Pliocene epoch. I can compare the specimens from Buenos Ayres with those from Mexico and Oregon, and Branco and Owen have given detailed descriptions of specimens from Buenos Ayres and Mexico. From these sources I learn of the existence of the following generic forms of Camelidæ. I omit Protolabis Cope,* and refer it to a separate family—the Protolabididæ, on account of the presence of three superior incisors in each premaxillary bone, as in the primitive Ruminantia, combined with the presence of a cannon bone.

I. Premolar teeth $\frac{4}{4}$.

P-m. i separated by diastemata.............................*Procamelus.*

II. Premolar teeth $\frac{4}{3}$.

P-m. ii below wanting......................................*Pliauchenia.*

III. Premolar teeth $\frac{3}{2}$.

Fourth inferior premolar triangular... ....*Camelus.*

Fourth inferior premolar composed of two crescents, which enclose a lake (an inferior P-m. 3 ?)..................................*Palauchenia.*

Fourth inferior premolar composed of two crescents, with two posterior tubercles behind them..............................*Protauchenia.*

IV. Premolar teeth $\frac{2}{1}$

Fourth premolar below triangular................ ....*Auchenia.*

V. Premolar teeth $\frac{1}{1}$

Fourth superior premolar composed of two crescents.......*Holomeniscus.*

Fourth superior premolar consisting of a simple cone..........*Eschatius.*

The position of this genus being determined as above, it remains to examine the material representing it, at my disposal.

In 1873 Dr. Leidy† described a large species of llama from specimens from California, which include the entire inferior series of molar teeth, and one superior molar. The first inferior molar, properly the fourth premolar, has the crown partially worn, showing that it was opposed by a grinding tooth in the superior series. In the Museum Nacional of Mexico is preserved a complete mandibular ramus, containing all the teeth of one side of an animal smaller than Dr. Leidy's type, but having a general resemblance to it; including the worn fourth premolar. In the collections of Professor Condon and myself from the Oregon desert, there are various isolated molars agreeing in measurements with Dr. Leidy's type, and belonging probably to the same species. In the Condon collection is part

* Proceedings Academy Philadelphia, 1876, p. 145.

† Report U. S. Geol. Survey Terrs., F. V. Hayden, i, p. 255, pl. xxxvii, figs. 1-8.

of a superior maxillary bone which contains the M. i and the alveolus of the P-m. iv, with the foramen infraorbitale anterius. The measurements of the M. i agree with those of the corresponding tooth of the lower jaw of Leidy's specimen. In the Museum of Mexico, there are preserved several superior true molars which also agree in dimensions with the corresponding teeth of the lower series of the type of the same *A. hesterna* of Leidy. The fourth superior premolar is wanting from this series.

The fragment of maxillary bone in the Condon collection shows that this species had a large three-rooted fourth premolar. It is broken off at the anterior alveolus, but it is so attenuated at that point as to make it almost certain that there was no third premolar in front of it, as is found in the genus Auchenia.

In further evidence of the existence of a genus characterized as above, by the absence of the P-m. $\underline{3}$, the jaw-fragment which represents the *Auchenia vitakeriana** may now be cited.

Holomeniscus vitakerianus Cope.

Although I ascribed a third superior premolar to this species, I must now deny its existence in the adult animal. A slight fossa on the narrow alveolar ridge indicates the possible presence of a single-rooted rudiment of such a tooth in the young. In a comparison of this species with the *Auchenia weddellii* Gervais, from the Pampean beds of Buenos Ayres, it is readily observable that the latter is a true Auchenia, with well developed P-m. 3 in the upper jaw, and that it is of larger and more robust proportions than the *H. vitakeriana*. In the only well preserved lower jaw which I possess, there is a well developed P-m. iii, a tooth found only as an occasional accident in *Auchenia lama* (teste Owen Odontography). In the *A. intermedia* Gerv., from the same locality, this tooth is wanting from one ramus, while the other displays a shallow vacuity as though such a tooth had existed in infancy and had been shed. I therefore retain these species in Auchenia.

HOLOMENISCUS HESTERNUS Leidy. *Auchenia hesterna* Leidy, loc. sup. cit.

The existence of superior molars in the Museum Nacional of Mexico which agree with the corresponding teeth of the Californian and Oregonian llamas has been mentioned above. I give the dimensions of these teeth as follows:

Measurements.			M.
Diameters M. i		anteroposterior	.041
		transverse	.033
Diameters M. ii	one individual.	anteroposterior	.041
		transverse	.040
Diameter M. iii		anteroposterior	.058
		transverse	.029

* Bulletin of the U. S. Geological Survey Terrs., 1878, p. 380.

These molars are covered with a layer of cementum, which is included in the measurements.

The mandible, I am disposed to refer to a smaller variety of this species for the present. The well-worn fourth inferior premolar indicates that it could not belong to the genus Eschatius, where there is no opposing tooth in the superior series capable of producing such a result. The hook below the condyle is well developed in this jaw. The incisor teeth are narrow. The canine is small and is separated from the incisors by a diastema. The triturating surface of the fourth premolar is triangular, and includes a lake. The molars increase in size posteriorly. The mental foramen is large, and is situated behind a point below the canine.

Measurements.		M.
Length of jaw from incisive alveoli to angle		.415
Height at coronoid process		.290
" at condyle		.218
" ramus at M. i		.070
" " " middle of diastema		.040
Length of symphysis		.096
" from base of incisors to canine		.043
" " canine to P-m. iv		.092
" of all the molars		.147
Diameters P-m. iv	anteroposterior	.022
	transverse	.013
Diameters M. i	anteroposterior	.035
	transverse	.019
Diameters M. ii	anteroposterior	.042
	transverse	.019
Diameters M. iii	anteroposterior	.048
	transverse	.016

From Tequixquiac.

A cannon bone in Condon's collection, which may belong to this species, measures fifteen and a quarter inches in length. So far as the evidence gòes it may as well have belonged to the *Eschatius conidens*. According to Leidy the cannon bone of the *Auchenia californica* Leidy measures nineteen inches in length. A cannon bone of at least this size, with other bones of the skeleton, occurs in the museum of the School of Mines, and may belong to the Californian species. Whether that species is a true Auchenia or not remains uncertain, as the teeth are unknown.

ESCHATIUS, gen. nov.

This genus is well characterized by the reduction of the fourth superior premolar to a simple cone, in place of the usual double crescent characteristic of the Ruminantia generally. This is the greatest known reduction of the premolar series in the Ruminantia, exceeding anything in the Bovidæ, a family otherwise more specialized than the Camelidæ. If my

identification of mandibles be correct, there is but one inferior premolar, which is not prismatic, but has two divergent roots as in Auchenia. The crown is compressed. In any case this genus is distinct from Palauchenia Owen, which is said to have the fourth inferior premolar composed of two crescents, somewhat as in the Protauchenia of Branco. There is also a simple conic third inferior premolar according to Owen. The type specimen of the type of Palauchenia, *P. magna* Owen, consists of isolated teeth put together in a bed of plaster of Paris. While there may be some uncertainty as to the position of the third premolar, I cannot agree with Professor Leidy* in the supposition that these teeth have been inverted by their describer, and really belong to the upper jaw. The specimen is preserved in the museum of the School of Mines, and I did not observe any second one.

ESCHATIUS CONIDENS, sp. nov.

Primarily established on a superior maxillary bone, which contains all its teeth, which is preserved in the Museum Nacional of Mexico. I cannot distinguish from this individual another one which was found by Mr. C. H. Sternberg in the desert of Oregon, and which is represented by a good many fragments, including parts of both jaws. I describe the Mexican specimen first.

The true molars increase rapidly in size posteriorly. The vertical ribs of the external anterior horns of the external crescents are very strong, and the external wall of the anterior crescent has a low rib on the median line also. The posterior internal crescent of the last superior molar (which is not much worn) sends its anterior horn to the external wall, thus cutting off the posterior horn of the anterior internal crescent.

Measurements.		M.
Length of the four superior molars		.126
" " M. i		.041
Diameters of M. ii	transverse at base	.024
	anteroposterior	.044
Length of M. iii		.051

The *foramen infraorbitale anterius* issues above the anterior rib of the posterior crescent of the first true molar. The specimen is from Tequixquiac.

The Oregon specimen includes a left maxillary and mandibular bones, with the roots or alveoli of the teeth remaining, together with numerous bones of the skeleton. As one or two teeth of the *Holomeniscus hesternus* are mingled with the other pieces, it becomes uncertain to which of the species some of the bones should be referred. This is the more difficult, as the superior molar teeth of the two animals are of nearly the same dimensions. The probabilities are, however, that the greater number accompany the species represented by the jaws. I proceed to describe the latter.

In the maxillary bone the single alveolus of the fourth premolar is close

* Report U. S. Geolog. Survey Te:rs, I, p. 256.

to that of the anterior root of the large first true molar. Its section is a wide oval. The base of the second true molar is not longer than that of the first true molar. The external wall of the maxillary bone is broken so that the position of the infraorbital foramen cannot be positively ascertained. A narrow groove, which may be a part of the infraorbital canal, is exposed, and is continued forwards to a point anterior to the first premolar, where it probably issues. If this be a correct inference, its position is anterior to that observed in the Mexican specimen. The palatine foramen issues opposite the anterior root of the first true molar. In the *Holomeniscus hesternus* this foramen issues opposite the fourth premolar's internal root.

The fragment of mandible is the anterior part of the left ramus, including the premolar and half the symphysis. The fundi of the anterior alveoli only are preserved. That of the canine is smaller than those of the incisor teeth, and is close to that of the external incisor. The mental foramen is large, and is situated posterior to the mouth of the alveolus of the canine. The symphysis is not coössified. The alveolar edge of the diastema is narrow, and presents a narrow vertical parapet outwards, which makes an angle with the external convex side of the ramus. The inferior outline below the diastema is a little concave. The roots of the premolar are well separated. The crown is lost. The coronoid process, supposed to belong to the same species, is like that of the llama, near the condyle, and is quite elevated. It maintains its anteroposterior width to near the summit. Anterior edge rounded, the bevel extending on the external face towards its base. The posterior rotula of the condyle is median, and not on one side as in the llama and in the camel. The anterior part of the face presents forwards as in the llama, and is not so much expanded as in the camel. The petrous bone is as large as that of the camel, and has a more widely open styloid fossa, which is directed more inwards in the downwards direction. The face also for the paroccipital process approaches much more nearly to its fundus than in either the camel or the llama.

Measurements.	M.
Long diameter of alveolus of superior P-m. iv	.009
" " " " M. i.	.036
" " " " M. ii	.038
" " " inferior P-m. iv	.022
Length of inferior postcanine diastema	.070
Depth of ramus at middle diastema	.035
" " P-m. iv	.045

It still remains to be ascertained whether this Oregon Eschatius belongs to the species that is found in the Pliocene beds of the valley of Mexico.

Eschatius longirostris, sp. nov.

This llama is known to me from a right mandibular ramus, which is broken off behind the last molar tooth, and which supports the symphyseal portion of the left ramus, less its external wall. In size this species is be-

tween the *Auchenia weddelli* Gerv. and the *Eschatius conidens*, having just about the dimensions of the *Camelus dromedarius* or the *Palauchenia magna* Ow. It differs from the *Eschatius conidens* in the much longer inferior diastema, longer, coössified symphysis, and smaller true molar teeth; the comparison being made with superior molars of the *E. conidens*.

The alveolus of the inferior canine tooth is small, and is a short distance posterior to the third incisor, being separated by a short diastema. The mental foramen is very large, three times the size of that of the *E. conidens*, and its anterior edge is 20 mm. posterior to the canine alveolus. The alveolar parapet of the diastema is not so elevated as in *E. conidens*, but is distinct. The dentition shows that the animal is an old one. The fourth premolar has two divaricate roots, which spread nearly as far anteroposteriorly as those of the first true molar. The crown is compressed. Apex broken. The crowns of the molars are worn; that of the first to the roots. The heel of the third true molar is lost.

Measurements.	M.
Width of mandible at inferior canines	.027
Length of inferior postcanine diastema	.110
" " molar series	.132
" " P-m. iv	.027
" " M. i	.029
" " M. ii	.034
Width of " M. ii	.022
Depth of ramus at middle diastema	.043
" " P-m. iv	.058

From the Oregon desert; Professor Condon's collection.

BOS Linn.

BOS LATIFRONS Harlan.

This species is represented by numerous remains, and must have been abundant in Mexico during the Pliocene epoch.

On the structure of the feet in the Extinct Artiodactyla of North America.

By E. D. Cope.

(Read before the American Philosophical Society, August 15, 1884.)

The structure of the feet of a number of the Artiodactyles of the Tertiary beds of North America has already been described. In this paper I enumerate these, and add descriptions of some types which have been hitherto unknown. I commence with the Bunodonta.

BUNODONTA.

PANTOLESTES Cope.

The structure of the tarsus only of this Eocene genus is known.*

* Cope, Proceedings American Philosophical Society, 1881, p. 188. Pal. Bulletin, No. 34.

The cuboid and navicular bones are distinct from each other and from the cuneïforms, and the ecto- and mesocuneïform are coössified. There are four metatarsals. The laterals (ii and v) are slender; and the medians are distinct but appressed, their adjacent sides being flattened. This foot structure is remarkably advanced considering the early age, Wasatch Eocene, of the period of its existence, and the primitive, tritubercular bunodont character of the superior dentition. The selenodont types which appear first in our series of formations, the Oreodontidæ of the White River low Miocene, present a much more primitive type of foot. The camel series is remarkable for the early and continued absence of the first and fifth metapodial bones. The first known of the line, Poëbrotherium, from the White River beds, has only minute rudiments of them. It is probable the Pantolestes, or some member of the Pantolestidæ, is an ancestor of Poëbrotherium, with a number of lost types intervening.

ELOTHERIUM Aym.

The first information respecting the structure of the feet of this genus was furnished by Marsh.* He says "The radius and ulna were separate or very loosely united. The third and fourth metacarpals were nearly equal in size, and the second and fifth longer than the corresponding bones of the pes. In the latter the first digit was wanting, and the fifth rudimentary." This description leaves us in the dark as to the development of the second digit in the posterior foot and of the second and fifth in the anterior foot. The ambiguous language led me to infer that there are four digits of the anterior foot of the animal described by Marsh, and hence to separate it generically from Elotherium. The first definite information is derived from Kowalevsky, from his great memoir on the genus Anthracotherium.† He here states distinctly that the genus is bidigitate, but with small rudiments of the second and fifth metapodial bones. He shows also that the lunar is equally supported by the magnum and unciform. In a memoir especially devoted to this genus‡ he also shows that the cuboid, navicular and cuneïforms are distinct, while the ecto- and mesocuneïforms are coösified, the entocuneïform being absent. The structure of the tarsus in this genus is then as in Pantolestes, and from this genus or one of the same family, Elotherium no doubt took its origin through intermediate genera.‖

SELENODONTA.

OREODON Leidy.

We owe to Leidy the following statement regarding the foot structure of this genus.§ What are supposed to be the bones of the forearm and leg

* American Journal Sci. Arts, 1873, p. 487, June.

† Palæontographica, 1873, p. 188, August ?

‡ Loc. cit., xxii, N. F. II, 7, p. 415.

‖ I have given the structure of the anterior leg and foot in *Elotherium imperator*, Bulletin U. S. Geol. Surv. Terrs., Vol v, p. 60.

§ Extinct Mammalia of Dakota and Nebraska, 1869, p. 72.

are discrete, as in the hog; and the bones of the feet correspond in number with those of this animal. In 1873, Professor Marsh confirmed these statements as regards the metacarpal bones,* and added "that the navicular and cuboid bones were loosely coösified or separate." In 1884† I gave a full account of the structure of the limbs in this genus. I mentioned a peculiar feature of the carpus, viz.: that the os lunare is supported below by the inward extension of the unciform, so that the magnum is below the scaphoideum. I also showed that the cuneïforms are distinct, and that the entocuneïform is wanting.

EUCROTAPHUS Leidy.

I have already stated that this genus is tetradactyle anteriorly and posteriorly.‡ I now add that the structure of the limbs and feet is in other respects like that of Oreodon. This is true of the inner extension of the unciform, so that the magnum is below the trapezoïdes. The inner side of the latter bone in the *Eucrotaphus pacificus*, is so excavated, that there was plainly a free trapezium of small size. In the posterior foot the entocuneïform is wanting, and the mesocuneïform is distinct from the ectocuneïform.

MERYCOCHŒRUS Leidy.

The first information of the foot structure of this genus is contained in my paper on the Oreodontidæ above cited.‖ The fore and hind feet are there stated to be tetradactyle. I now add that in the *M. montanus* Cope, the os magnum is entirely below the scaphoid, and that there is a distinct trapezium. The posterior foot is constituted as in Eucrotaphus; I also observe that the navicular has a peculiar little facet on its distal face near the front of the external edge. This fits a corresponding facet which forms the proximal surface of a ledge, which extends from front to rear on the inner side of the cuboid. In *Eucrotaphus pacificus* the arrangement is similar, excepting that the ledge of the cuboid is interrupted at the middle by a deep excavation. In *Merychyus arenarum* the cuboid is like that of *Merycochœrus montanus* in regard to this ledge.

MERCHYUS Leidy.

The limbs and feet in this genus are quite as in Merycochœrus. The species which I have examined is the *M. arenarum* Cope.

LEPTOMERYX Leidy.

We possess as yet no information regarding the limbs and feet of this genus. It is therefore fortunate that I obtained in the White River bed of North Eastern Colorado, in 1879, a nearly entire skeleton of the *L. evansi* Leidy. The bones were all found close together, and belong to two individuals, and are without admixture of those of any other species.

* Amer. Jour. Sci. Arts, p. 400; Marsh does not credit Leidy with his previous observations.

† Proceeds. Amer. Philos. Society, Pal. Bulletin, No. 38, pp. 503—10.

‡ Loc. cit., p. 504.

‖ Proceeds. Amer. Philos. Society, 1884, p. 504.

From these, and inferentially from other specimens, is derived the curious fact, that there are four distinct metacarpals, all supporting digits, while there are but two metatarsals, which are coösified into a cannon bone. This diversity between the limbs is unparalleled, although an approach to such a condition is seen in the peccary. In this animal, as is well known, there are four distinct digits in the manus, while in the pes, the metatarsals are coössified proximally, and the fifth metatarsal is reduced to a scale. This difference between the two limbs is a further illustration of Mr. Ryder's statement that the posterior limb is in advance of the anterior in grade of development, for which I have endeavored to account by reference to the fact that it is the posterior foot which receives the greater number of impacts in progression. This is because the hind limb is the principal propeller of the body.

In accordance with the structure of the feet, the fore-limb is much behind the posterior limb in the fixity of its parts. The ulna and radius are distinct; the head of the latter a regular transverse oval. The distal extremity of the fibula is not coössified with the tibia, but forms a separate bone, as in the Ruminantia.

The lunar is mainly supported by the unciform, so much so that the front face of the magnum is not beveled to fit the former. Behind the face, the edge of the magnum is a little beveled for the lunar; but the former bone lies almost entirely under the scaphoid. The trapezoïdes is coössified with the magnum. No distinct trapezium.

The cuboid and navicular are solidly united. The ecto- and mesocuneïforms are distinct, and there is no entocuneïform. The second metatarsal is represented by a flat oval bone which is borne on the underside of the projecting heel of the third metatarsal. The fifth is of smaller size, and is a scale imbedded in a depression of the posterior part of the side of the fourth. Ungues unilateral, trihedral and acute.

HYPERTRAGULUS Cope.

Remains of this genus are as abundant in the White River beds as are those of Leptomeryx, and like that genus I know but the one species, the *H. calcaratus* Cope. Unfortunately I have not been able to obtain bones of the skeleton connected with dentition from this formation, although numerous bones occur separately which probably belong to it. The genus is however abundantly represented in the John Day Miocene beds of Oregon, where Leptomeryx does not probably occur. At least no specimens of the latter are to be found in a collection of between one and two hundred individuals of this general type in my collection. I cannot distinguish the John Day species from the *H. calcaratus*, although the size is generally distinctly larger.* In other cases the size is the same. To the John Day specimens then I refer for the characters of the feet of this genus.

* It is probably this species that is cited by Leidy as the *Leptomeryx evansi* in the Report U. S. Geol. Survey Terrs. I, p. 216.

The ulna and radius are coösified. The scaphoid and lunar facets of the radius are well distinguished by an oblique ridge. The carpus is unknown. The median metacarpals are separate; whether the second and fifth are well developed I do not know, but suspect them to be so, as in Leptomeryx, since the third and fourth bear no adherent rudiments. The cuboid and navicular bones are united, while the cuneïforms are distinct from them and from each other, as in Leptomeryx. There are but two developed metatarsals, and these are distinct from each other. Thus the fore-limb in its ulno-radius exhibits a little advance over Leptomeryx; while in the separate metatarsals it is behind the latter.

HYPISODUS Cope.

This genus is remarkable for its prismatic dentition, being the only Artiodactyle presenting the character in the White River fauna.* It was probably well advanced in foot characters, but of these I know but little. Parts of two tarsi found with the jaws of the *H. minimus* Cope, are referred to the species on account of their very small size, and general correspondence. The cuboid and navicular are coössified. Their distal face, especially the navicular part, is so narrow transversely, that it is almost certain that the third and fourth metatarsals are coössified, and that the second and fifth are rudimental or wanting. There is no trace of facets for the latter on the naviculo-cuboid.

POËBROTHERIUM Leidy.

I have fully described the limbs of this genus in the Annual Report of the U. S. Geological Survey of the Territories for 1873†, as seen in the *P. vilsoni* Leidy, from the White River beds, and have confirmed them from a fine specimen of the *P. sternbergi* Cope, from the John Day or Middle Miocene of Oregon.‡ The characters are; ulna and radius coössified; trapezium and trapezoïdes present and distinct; magnum supporting part of lunar. Two distinct metacarpals, scales representing the second and fifth; navicular and cuboid bones distinct, as are the ecto- and mesocuneïforms; entocuneïform wanting. Metatarsals two, distinct; second and fifth represented by scales.

OBSERVATIONS ON THE PHYLOGENY.

I have maintained ‖ that the selenodont dentition is a derivative of the bunodont, a proposition which seems unavoidable from a mechanical point of view. The testimony of palæontology is also in its favor, since in America the oldest artiodactyle, Pantolestes, is bunodont. Kowalevsky in the phylogenetic table given in his monograph of Anthracotherium§ does

* See Cope, Annual Report U. S. Geological Survey Terrs., 1873, p. 501, where the cuboid and navicular are stated to be united.

† 1874, p. 499.

‡ Bulletin U. S Geol. Survey Terrs. V, p. 59.

‖ Journal Academy Natural Sciences, 1874. See also Ryder, The Mechanical Genesis of tooth forms, Proceeds. Academy Philada., 1879, p. 47.

§ 1873 (?4), p. 152.

not commit himself as to this point, but allows the development of the two types of dentition to appear to have been cotemporary and from some common origin. He then derives from such a common point of departure first, the Hyopotamidæ, which first appear in the Eocene, and second, the ancestors of the Anoplotheriidæ. From the Hyopotamidæ he derives all the modern Selenodonta, exclusive of the Camelidæ. The latter group he omits from his table, doubtless because his information on the subject was insufficient. The main line of origin of the Selenodonta is divided early in Miocene time, the genus Gelocus giving origin to the Pecora, and the genus Hyæmoschus to the Tragulina.

In describing the characters of the genus Poëbrotherium for the first time, I remarked as follows :* "The present genus is a more generalized type than Gelocus, and in its distinct trapezoïd and distinct metacarpals represents an early stage in the developmental history of that genus. It also presents affinity to an earlier type than the Tragulidæ which sometimes have the divided metacarpals, but the trapezoïdes and magnum coössified. In fact Poëbrotherium as direct ancestor of the camels, indicates that the existing Ruminantia were derived from three lines represented by the genera Gelocus for the typical forms, Poëbrotherium for the camels and Hyæmoschus for the Tragulidæ."

These views being then established on sufficient evidence, it remains to make such additions as the facts cited in the present paper indicate. First in importance comes the place in the phylogeny of the Selenodonta, of the Oreodontidæ. The peculiar inward extension of the unciform bone already ascribed to them, characterizes also among extinct forms the genus Leptomeryx, and probably Hypertragulus. Among recent ruminants it is only seen in the Tragulidæ.† If we arrange these types in serial order we find the modifications of form to be generally identical with those of the other ruminant lines, in the coössification of the bones of the legs and feet. This series may then be regarded as phylogenetic. The peculiar structure of the carpus of the Oreodontidæ, puts them out of the question as ancestors of any type of existing ruminants other than the Tragulina. Whether they themselves can be traced to a five-lobed, or to a four-lobed bunodont ancestor, remains an undecided question. It is not, however, probable that a five-lobed form has been intercalated in a series, both of whose extremities are four-lobed. If this be true, the Oreodontidæ must be regarded as an ancestral type of Selenodonta, coëqual with the Hyopotamidæ, and it may well be questioned whether the latter can have been ancestors of the existing Ruminantia, whose molars are four-lobed.

So the present investigation does not disclose the ancestral stock of the Pecora. In North America we have not progressed further in the solution of this question than I reached in 1877,‡ after a study of the genera

* Bulletin U. S. Geol. Survey Terrs. Vol. 1, No. 1, p. 26, Jan., 1874.

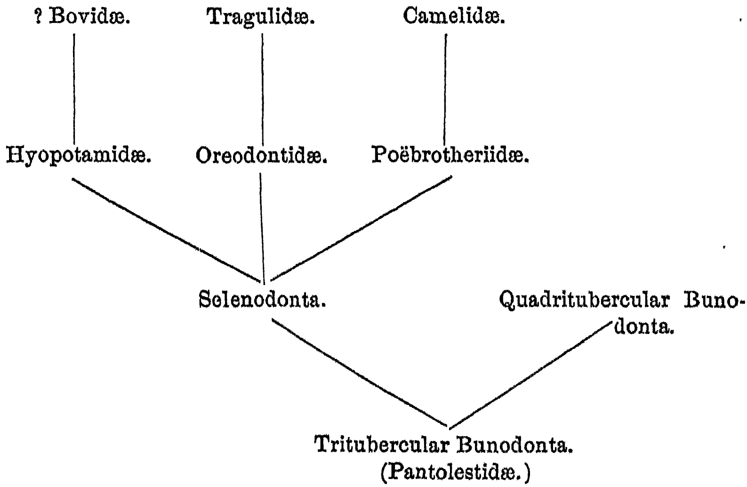
† Among Perissodactyles it occurs in Triplopus, Tapirus and the Rhinocerontidæ.

‡ Proceedings Amer. Philos. Soc., p. 223.

Cosoryx Leidy, and Blastomeryx Cope. I had already* suggested that the former genus is the ancestor of the Cervidæ, but subsequently† remarked: "It is not probable this genus is the immediate ancestor of Cervus, from the fact that the molar teeth display in their prismatic form a higher degree of specialization than belongs to that genus. It is probable that the true ancestor combined the dental type of Cervus with the distinct roots and short crowns of the molars, with the type of horns here described." I at that time included a species (*Cosoryx gemmifer* Cope) in the genus, provisionally, which has the type of molars in question. Having discovered another, larger species, which has the same type of molars, I at once distinguished the provisional group in which I had placed the *C. gemmifer*, Blastomeryx, as a genus; and in describing the species (*B. borealis*) observed as follows:

"In brief, its molars differ from those of Cosoryx ("Dicrocerus") much as those of the deer differ from the molars of the antelope. While Cosoryx ("Dicrocerus") was probably the ancestor of Antilocapra, Blastomeryx was the ancestor of Cervus or Cariacus." This opinion expresses all the information I possess on the subject at present. It remains to ascertain the structure of the anterior feet in Hypisodus, which is the earliest genus of Ruminantia known to have prismatic molars.

The following table will represent the views expressed in the preceding pages:



* Proceedings Academy Philadelphia, 1874, p. 149.

† Report Expl. Surv. W. of 100th Mer. U. S., G. M. Wheeler in charge, iv, pt. ii, p. 349, 1877.

*Fifth Contribution to the Knowledge of the Fauna of the Permian Formation of Texas and the Indian Territory. By E. D. Cope.**

(Read before the American Philosophical Society, August 15, 1884.)

PISCES.

CERATODUS FAVOSUS, sp. nov.

This species is known to me from a piece of the lower jaw, which supports a tooth. One extremity of the tooth is broken off, but from the curvature of its inner side, it is to be inferred that the portion lost is but small, probably including one of the three processes which the tooth possesses. The species may be distinguished from those described by Agassiz, and from the existing species, by the great depth of the two emarginations of the external side. These enter the crown so deeply as reduce its width to dimensions no greater than those of each of the processes of the crown. The internal face is strongly convex, and one extremity is more strongly recurved than the other. The crown consists of a mass of coarse perpendicular simple calciferous tubules, which are enclosed in a rather thin layer of a dense substance which thickens downwards, and laps over the external face of the jaw bone. The external surface of this layer is vitreous. The walls of the tubules are of a dense and hard substance, of a darker color in the fossil, and the tubules are filled with a softer substance, so that the grinding surface of the crown has the appearance of a small honeycomb. The diameter of the tubules ranges from 1. to .05 mm. The fragment of jaw is robust, is deeper than wide, and is strongly convex on the internal face. The internal inferior angle rises at one extremity above the level of the external inferior angle. The processes of the crown project freely beyond the bone, having rested on the cartilage which forms the external face of the jaw, as Günther has shown to be the case in the *C. forsteri*.

Besides the deep emarginations of the crown, the coarseness of the calciferous tubules is a special character of this species.

Measurements.	M.
Depth of jaw with tooth	.019
" " without tooth	.012
Width of crown at middle process	.014
Probable length of crown	.022

Found by Mr. W. F. Cummins.

Agassiz did not record any species of this genus from below the Trias, but Fritsch has reported them from the Permian of Bohemia.

BATRACHIA.

CRICOTUS CRASSIDISCUS, sp. nov.

Accession of additional material enables me to add several points to the

* The "Fourth Contribution" will be found at page 628 of these Proceedings for the year 1883.

knowledge of the osteology of this genus, and to distinguish satisfactorily three species. I have much pleasure in obtaining these additional facts, since everything relating to this curious genus is of interest.

In the first place, the neural arches are not coössified to the centra, but are readily separated from them. Their basis of attachment forms, on each side of the median neural canal, an oblique triangular surface looking forwards and upwards, with the apex above and behind. The ease with which the neural arches separate accounts for the rarity of their occurrence on separate centra. They support the diapophyses at their lower border. Second, that the sacrum consists only of a centrum and an intercentrum, both of which take part in furnishing a concave facet for the attachment of the pelvis. Third, some of the ribs are two-headed, and their capitular articulation is with the posterior edge of the intercentrum. Fourth, there is a hyposphenal articulation, as in the genera of Jurassic Saurians, Camarasaurus, Amphicœlias, etc., and in the Permian genus Empedias, among the Theromorpha. The hypantrum has, however, this peculiarity : that its sides are produced forwards into a process on each side below the prezygapophyses, each of which is subconical in form, but with the interior face excavated to receive the hyposphen, so that the section of the process is crescentic. These processes I have never previously observed. I call them hypantrapophyses. I find them in the *Cricotus hypantricus*. The neural arches of the other species are either lost or in such close juxtaposition that I cannot see them.

The species differ in part as follows; the full characters can only be given in more detailed descriptions of more perfect specimens.

I. Dorsal intercentra much narrowed or pinched above.
Hypantrum unknown.................................... *C. heteroclitus.*

II. Dorsal intercentra equally robust above as below, or more so.
Hypantrum unknown.................................... *C. crassidiscus.*
Hypantrum with acute lateral processes.................. *C. hypantricus.*

The measurements of the *C. crassidiscus* are as follows:

Measurements.			M.
Diameters of dorsal centrum behind	vertical		.025
	transverse		.025
Length of do.	middle line below		.013
	at base of neural arch		.013
Base of neural arch	width		.010
	length		.009
Diameters of a dorsal intercentrum	vertical		.025
	transverse		.025
Length of do.	middle line below		.009
	" " above		.0095
Diameters of coracoid	transverse length		.027
	width	at glenoid face	.029
		at internal face	.010

It is probably this species which I have figured in the Proceedings of the American Philosophical Society,* and American Naturalist,† under the name of *C. heteroclitus*. It is the most abundantly represented in my collection. In the specimen figured in the American Naturalist, the probable scapula is visible on both sides, but the coracoid is concealed by the pectoral scuta.

CRICOTUS HYPANTRICUS, sp. nov.

This Embolomere is probably represented by two individuals, which are of larger size than any species which have hitherto come under my notice, one of them very much larger. It is only the smaller specimen which is accompanied by the astragalus. Both of them display the hypantrapophyses already mentioned in remarks on the genus under the head of *C. crassidicus*.

As already pointed out in the key of species, the dorsal intercentra in the *C. hypantricus* are stout and not narrow above, but the thickness increases rather than diminishes upwards. They thus differ from the corresponding intercentra in the *C. heteroclitus*. In many of the dorsal intercentra the dense external layer which covers the inferior face continues upwards to an apex, the articular surfaces of the two ends meeting so as to exclude the former. This is also the case in the *C. crassidiscus*. The centra have the abbreviated form characteristic of the genus, and the foramen chordæ dorsalis is present, but is smaller than the *C. heteroclitus*.

The supposed astragalus is oblong; proximal‡ border longer than the distal, which is separated by an obtuse angle from the ectad; distal entad not reaching superior surface of bone, long, extending inwards below the revolute proximal part of the entad face, from which it is separated by a narrow oblique groove. Proximal and distal entad separated by notches of the two faces; a ridge the length of the bone below.

Measurements.		M.
Diameters of centrum of individual with astragalus.	anterposterior	.015
	transverse	.028
Diameters of astragalus	anterposterior	.038
	transverse	.029
Diameters of centrum of larger individual.	anteroposterior	.018
	transverse	.038
Diameters adjacent intercentrum of do.	anteroposterior	.018
	transverse	.038

REPTILIA.

CLEPSYDROPS LEPTOCEPHALUS, sp. nov.

This species is represented by almost the entire skeleton, the principal deficiency being that of the scapular arch and the anterior limbs, with the

* 1881, pl. ii, figs. *a–b*.
† 1884, p. 39, pl. v and fig. 7. In pl. v, figs *f* and *g* represent the *C. heteroclitus*.
‡ I determine the ends of this specimen from a foot of Eryops.

phalanges of the posterior feet. The bones of the skull are mostly preserved, but in a dislocated condition. They serve to demonstrate some of the characters of the genus and family.

The quadrate bones of both sides are distinctly displayed. They are rather short, and articulate above by squamosal suture with the squamosal bones, which overlap them posteriorly. They narrow upwards, and are deeply grooved on the anterior face below. Each edge of the groove is produced forwards; the external for a considerable distance as an acuminate laminiform process, in the usual position of a quadratojugal bone. The production of the internal edge is shorter, and its extremity is vertically truncate. Its superior edge fits an incurvature of the superior edge of the pterygoid bone, and its internal face is applied to the external face of the latter.

The pterygoid bone displays the subtriangular plate with dentigerous edges, such as I have already described as present in the species of Dimetrodon. In this species it is thinner and less massive than in any species of that genus yet known. This specimen enables me to locate it more precisely than heretofore. The pterygoids were probably placed much as I have represented them to be, in the *Empedias molaris* Cope (Proceedings American Philosoph. Society, vol. xix, p. 56, pl. v). They send inwards a subtriangular plate from each side, which approach each other on the median line without touching, and the adjacent edges are somewhat decurved. The posterior edges are deeply concave on each side of the middle line, and like the inferior edges, are dentigerous. The process for the quadrate extends outwards and backwards, and is thickened on its posterior edge, while its anterior edge, which is continued from the inferior edge of the posterior border, becomes very thin. The anterior production for the ectopterygoids extends outwards and forwards, leaving the anterior edge of the dentigerous plates as the concave posterior border of the large palatine foramina. The anterior production of the internal edge of the plate becomes very thin, and is broken in the specimen without showing articulation for the palatine.

The squamosal extends both above and below its anteriorly directed zygomatic portion. The superior extremity shows squamosal suture for the parietal.

The stapes is of large size. It consists of a stout rod terminating in a double extremity, something like the double head of a rib. The shorter head is expanded into a funnel shape. Near to it the shaft is perforated in the longer diameter by a foramen. The extremity of the other head is transversely truncate and is separated from the funnel by a deep notch. On the outer side of the fundus of this notch, a foramen penetrates the shaft obliquely and is continued into a canal which issues at the foramen first described. The distal end is truncated by an irregular sutural surface. In the specimen the bone lies behind the squamosal and quadrate bones, the simple extremity of the rod near the posterior edge of the quadrate.

The premaxillary bones are distinct. The teeth of that bone and of the maxillary are of unequal sizes.

The axis has an expanded neural spine, and a diapophysis for rib articulation, but no parapophysis or capitular fossa. The two latter features characterize all the vertebræ which follow, as far as the lumbar series.

The column in the typical specimen is tolerably complete, with a break of uncertain, but probably not great length in front of the sacrum, and the loss of the distal part of the caudal series. Intercentra of rather small size are present throughout the series anterior to the sacrum. The inferior faces of the caudal vertebræ are yet concealed by matrix. The bases of the neural spines are compressed; they were probably not elongate as in Dimetrodon, though they are unfortunately broken off, except that of the third cervicodorsal vertebra. Here the spine is short and truncate above, and rather wide anteroposteriorly. As in Dimetrodon there is no distinction between cervical and dorsal vertebræ.

The pelvis is well preserved, and has the characters already assigned to the *C. natalis* Cope.* The ilium has a process or narrowed continuation with parallel sides, directed backwards and upwards, and bearing a keel on the middle line on the internal side. The ischia are much produced posteriorly, and are separated by a notch on the middle line posteriorly.

The head of the femur is expanded, including probably the homologue of the great trochanter of mammalia, and its articular face is crescentic, with obtuse horns. There is a trochanter below it on the posterior edge of the shaft. The condyles are inferior, and are separated by a deep groove above and a shallow one below. The articular faces of the two condyles are continuous, forming and ∞-shaped figure. The proximal extremity of the tibia is wider than the distal, and the articular face is uninterrupted. That of the distal extremity is a transverse oval.

Specific characters. While the vertebral centra of this species are rather short, the bones of the head are very much attenuated, and the jaws are long and slender. None of the four jaws is prefectly preserved, but the number of the teeth in the maxillary bone may be approximately fixed at thirty in a continuous series. One, and probably two of these, placed near the anterior part of the series, are larger than the others. They are placed at the position of the corresponding large maxillary teeth in Dimetrodon, but they do not display the dimensions seen in the species of that genus. To strengthen the jaw at this point, a rib rises from the thickened alveolar portion, and extends vertically on the inner side of the thin facial plate of the bone. The facial plate is double, and each lamina, except at the rib, is not thicker than wrapping paper.

The premaxillary bones are robust, and are excavated postero-laterally for a very large nostril on each side. The spine is long. The alveolar edge bears five teeth, which are followed by a diastema. These diminish in size posteriorly, the first one being the largest, and equaling the large

* Proceeds. Amer. Philos. Society, 1878, p. 509.

maxillary teeth. The last two are quite small, less than the usual maxillary teeth.

The dentary bones are very slender, and the distal end is somewhat thickened to support two teeth larger than the others. These are the third and fourth from the extremity, and are not quite so large as the large teeth of the maxillary bone. The remaining mandibular teeth are small, and are not so much compressed as in the species of Dimetrodon. Many of them have only a posterior cutting edge, which is not denticulate. The apices are strongly turned backwards in the posterior part of the series. The posterior part of the dentary bone rises and carries some of the teeth with it.

The surface of the free edge of the internal plate or the pterygoid bone is granular. The teeth on the posterior edge of the same are subconic, and in a single series.

There are twenty-seven vertebræ in a continuous series, from and including the axis. All bear diapophyses, and all are rib-bearing, except perhaps the last two, where they are of reduced size. They are more or less opposite the neural canal as far as the twenty-second centrum. On this vertebra the superior edge is on a level with floor of the canal, and posterior to this point the diapophyses rise from the centrum. Two sacrals and ten caudals are preserved, and all have diapophyses and neural spines. The centra in this species are rather short, being as deep as long throughout the series, if measured at the middle. The edges are not undulate as in *C.* (*Embolophorus*) *limbatus* Cope. The intercentra are short and not extended upwards on the sides as in that species.

Measurements.	M.
Length of quadrate bone	.085
Width of condyle of quadrate bone (greatest)	.037
Length from condyle of internal anterior process of do.	.032
“ “ “ external “ “ “	.097
“ of squamosal bone (vertical)	.124
“ “ pterygoid from palatal foramen	.116
Width “ “ at middle	.090
Length “ internal dentigerous edge of do	.070
“ “ posterior “ “ “	.051
“ “ maxillary bone posterior to canine brace	.181
Thickness of “ “ at canine brace	.020
Depth of “ “ “ nostril	.016
Length of premaxillary bone (posterior apex restored)	.060
Width “ “ “ at third tooth	.022
Diameter of large (first) premaxillary tooth	.008
“ “ “ maxillary tooth (canine)	.009
“ “ small “ “	.006
Length of crown of last maxillary tooth	.009
“ “ twenty-seven continuous cervico-dorsal vertebræ	.855

Measurements.	M.
Length of two sacrals	.065
" " ten caudals	.200
Diameters centrum axis: anteroposterior	.084
Diameters centrum axis: vertical posteriorly	.081
Diameters centrum axis: transverse posteriorly	.080
Elevation of neural spine from centrum	.071
" " arch " "	.009
Width of postzygapophyses	.080
Elevation of neural spine of fourth vertebra	.058
Diameters centrum sixteenth vertebra: anteroposterior	.025
Diameters centrum sixteenth vertebra: vertical at end	.035
Diameters end centrum seventeenth centrum: vertical	.034
Diameters end centrum seventeenth centrum: transverse	.030
Expanse of postzygapophyses of seventeeth vertebra	.029
Diameters twentieth centrum: vertical at end	.031
Diameters twentieth centrum: anteroposterior	.027
Diameters of twenty-ninth centrum: anteroposterior	.024
Diameters of twenty-ninth centrum: transverse behind	.035
Expanse of postzygapophyses of twenty-ninth vertebra	.024
Width of sacrum through fixed diapophyses	.049
Diameters centrum twentieth caudal: anteroposterior	.025
Diameters centrum twentieth caudal: vertical behind	.0265
Diameters centrum twentieth caudal: transverse "	.0225
Expanse through diapophyses	.047
Elevation of prezygapophyses (greatest)	.039
Diameters of pelvis: anteroposterior (apex of pubis restored)	.235
Diameters of pelvis: vertical through acetabulum	.128
Anteroposterior diameter of ilium at acetabulum	.089
Depth of ischium at posterior edge of acetabulum	.080
Length of " from acetabulum	.117
Length of femur	.179
Proximal diameter of femur: anteroposterior	.075
Proximal diameter of femur: transverse (at middle)	.025
Diameters shaft at middle: transverse	.038
Diameters shaft at middle: anteroposterior	.031
Diameters of distal end: transverse	.068
Diameters of distal end: anteroposterior: external condyle	.031
Diameters of distal end: anteroposterior: internal "	.045
Length of tibia	.150
Diameters of tibia: proximal: anteroposterior (middle)	.040
Diameters of tibia: proximal: transverse	.057
Diameters of tibia: median: anteroposterior	.019
Diameters of tibia: distal: anteroposterior	.026
Diameters of tibia: distal: transverse	.041

The typical specimen of this species was found by Mr. W. F. Cummins in the Permian beds of Northern Texas.

CLEPSYDROPS MACROSPONDYLUS, sp. nov.

This species, like the last, much exceeds the *C. natalis* in dimensions. The bases of the neural spines are enlarged, so that it is probable that the spines were not elongate as in the species of Dimetrodon. Intercentra are present throughout the dorsal and caudal series of vertebræ. The dentary bone supports one or two large teeth near the extremity. These characters furnish the reasons for referring the species to the genus Clepsydrops.

The individual by which the species is known, is represented by an axis vertebra, twelve continuous dorsal vertebræ; nine other continuous vertebræ, of which three are lumbar, two sacral, and four caudal. Also by a part of the ilium, and by the greater part of a dentary bone. All of these specimens were found together, and possess an identical mineral appearance.

That this reptile belongs to a distinct species from the *C. leptocephalus* is readily determined by the form of the dorsal vertebræ. The centra are a little longer than those of that species, but have a smaller vertical diameter. The latter is three-fifths of the former, while in the *C. leptocephalus* the two dimensions are reversed, the depth being a little in excess in corresponding parts of the column. The dentary bone, on the contrary, is more robust than that of the *C. leptocephalus*, and supports, probably, a small number of teeth.

The edges of the centra are not undulate or laterally flared. The centra are strongly compressed, and in the anterior part of the column have an obtuse hypopophysial keel. The intercentra display equal width of the inferior surface; and are abruptly rounded at the extremities. The last one preserved is between the second and third caudal centra. It is shorter and wider than the others, and does not display any trace of a chevron bone. The diapophyses are opposite the neural canal on the thirteen anterior vertebræ preserved. Each one sends a horizontal rib forwards to the prezygapophysis, and another obliquely forwards and downwards which stops short of the edge of the centrum. These ribs enclose a fossa in front of the diapophysis. Posteriorly the anteroinferior rib grows more robust, and evidently supports part of the tuberculum of the rib. There is no facet for the capitulum until the antepenultimate vertebra of the anterior series is. reached. Here and on the penultimate the anterior border is flattened into a facet, and on the last of the series, the facet marks the summit of a distinct tuberosity, which is produced by the cutting away of the border below it, to accommodate the intercentrum.

The three lumbar vertebræ preserved are different from the dorsals in their greater abbreviation. This character is not unknown in other species of Pelycosauria. The centrum is contracted, but not compressed, at the middle. The diapophysis is altogether on the centrum, and supports no rib-facet. Its anteroinferior buttress is well developed, extending to the

margin of the centrum which is cut out below it for the intercentrum. The sacrum is rather robust. Its two vertebræ are not coössified, and support well developed neural spines, and a large free diapophysis for the ilium. The centra of the caudals, and their diapophyses and neural spines are well developed. There is a fossa at the base of the spine on each side, in line with the zygapophysial surfaces, equidistant between them.

The fragment of ilium is of appropriate size, and is quite robust. It displays the fossa for the sacral diapophysis, and the acetabulum. The latter is remarkable for the prominence of the tuberosity on the superior border, which exceeds that of any species of Pelycosaurian known to me. The section of the ilium through it is triangular.

The dentary bone is accompanied by the splenial to the middle of the symphysis. The latter is not very long. Its dentary portion turns upwards. The ramus is quite robust, differing much from that of the *C. leptocephalus*. It is broken off a little anterior to the tooth line, but the latter probably did not contain more than twenty-two teeth. These have anterior and posterior cutting edges, and are denticulate. The external face of the dentary is excavated by shallow, undulating, branching grooves.

Measurements.

			M.
Total length of vertebræ preserved			.640
Diameters centrum of a dorsal vertebra	anteroposterior		.031
	vertical behind diapophysis		.019
	transverse	at end	.021
		at middle	.0115
Diameters neural arch of same vertebra	length with zygapophyses		.041
	width at prezygapophyses		.022
Diameters neural spine of same vertebra	anteroposterior		.0145
	transverse behind		.007
Diameter of intercentrum of do	anteroposterior		.0052
	transverse		.023
Diameters of a lumbar centrum	anteroposterior		.024
	transverse at end		.026
	" " middle		.023
	vertical behind arch		.022
	" at end		.029
Length of sacrum			.055
Diameters of third caudal vertebra	anteroposterior		.024
	vertical at end		.023
	transverse at end		.022
Anteroposterior diameter of acetabulum			.0325
Transverse diameter of ilium at tuberosity			.0265
Length of dentary bone supporting twenty teeth			.044
Thickness at twentieth tooth			.0175
Depth ramus at second tooth			.035
" " " fifteenth tooth			.039

The bones of this specimen are in excellent preservation. They were recovered by Mr. W. F. Cummins from the Peruvian beds of Texas.

EDAPHOSAURUS MICRODUS, sp. nov.

The genus Edaphosaurus Cope, was established on the *E. pogonias* Cope (Proceed. Amer. Philos. Soc., 1882, p. 448), which is represented by a specimen, which includes only a distorted cranium, with most of the parts preserved. The present species is represented by an individual of which I possess numerous vertebræ and ribs, and the dentigerous plates of both jaws. These are part of the dentary splenial in the inferior jaw, and the pterygoid or palatine of the superior. The specimen enables me to determine the characters of part of the vertebral column in the genus Edaphosaurus.

In the first place the vertebræ possess enormously elongate neural spines, as in Dimetrodon. Next, the centra have a facet on the anterior edge above the middle for the head of the rib, as in a mammal. It is not repeated on the posterior edge of any of the thirteen centra preserved. Thirdly, the ribs are only compressed proximally. Distally their section is a wide oval. The extremity is truncate and concave. The shaft is hollow, the walls being thinnest distally.

Specific characters. The grinding teeth of this species are about as numerous as in the *E. pogonias*, there being about seven in a transverse row on each plate. They are, however, less closely placed than in the typical species, and have more conic crowns. They do not form a pavement, as they are separated by wider interspaces.

The centra are rather elongate, and the *foramen chordæ dorsalis* is rather large. No intercentra are preserved, and if present they must have been very small, as the inferior rim of the centrum is not beveled to receive one. The neural spines have transverse processes which commence near the base, and project at intervals from the sides. The inferior ones are oval or subround in section; those which succeed are more or less compressed. The extremities are enlarged fore and aft so as to be claviform in outline, but are compressed except where thickened by lateral tuberosities. These are rarely symmetrical, one being larger and situated higher up, sometimes giving the apex an unsymmetrically bilobate form. Sometimes they project at right angles to the terminal expansion. The shaft of the spine has a rather small medullary cavity, and this issues by an open mouth at the summit of the apex without constriction. This peculiar arrangement suggests a cartilaginous continuation of the spine which retains the nutritive artery of the medullary cavity. The anterior face of the shaft is grooved from the base for some distance upwards; the posterior face is plane and then rounded above.

Measurements.		M.
Diameters of inferior dental patch	anteroposterior....	.043
	transverse........	.024

Measurements. M.

Diameters of a posterior dorsal centrum......	anteroposterior		.0335
	vertical at end		.027
	transverse	at end	.026
		at middle	.015
Measurements of piece of spine of same....	length		.132
	diameter at base.	anteroposterior	.023
		transverse	.019
Diameters of median dorsal............	vertical..	at end	.032
		behind arch	.025
	anteroposterior		.0465
	transverse	at end, at flare	.037
		at middle	.016
Diameters of summit of spine	anteroposterior		.032
	transverse		.032

The ramous character of the neural spines of this species is much like what is seen in the *Dimetrodon cruciger* Cope. The rami in this species, however, retain their size upwards, and become compressed, a feature not seen in the *D. cruciger*. The apices of the spines in the latter species are not dilated as in the *E. microdus*.

Found by W. F. Cummins in the Permian beds of Texas.

THE POSTERIOR FOOT IN PELYCOSAURIA.—The foot-bones of the reptiles of the suborder Pelycosauria are abundant in the collections from the Permian formation, and I have examined my collection for specimens in which they are in normal connection, for the purpose of identifying them. I have been so fortunate as to find an entire tarsus, with the proximal parts of the metatarsi, in the skeleton which served as the type of my description of *Clepsydrops natalis*.* The characters presented by this foot are no doubt present in all of the Clepsydropidæ, which includes the genera Theropleura, Dimetrodon, Embolophorus, and probably others. Tarsal bones identical with those of the *C. natalis* were found with the original specimens of *C. collettii* and others of much larger size, accompany remains of species of Dimetrodon, or Embolophorus.

The astragalus and calcaneum are large and well specialized bones, distinct from each other and from the other tarsal elements. They do not resemble the corresponding bones of any known type of vertebrate, as will presently appear. The navicular bone is distinct, and the cuboid apparently consists of a single element. This depends on the interpretation given to a small bone on its posterior face, which is broken on its free edge, and may be the head of the fifth metatarsus. There are three elements in contact with the distal face of the navicular, which correspond with the three mammalian cuneïforms. The space available for this contact seems hardly sufficient for the three elements present, one of which is out of position and on the inferior side of the carpus. This element

* Proceedings American Philosoph. Society, 1879, 509.

looks also from its free inferior side like an ungual phalange, but is flatter than is characteristic of this family. There are three metatarsals distal to the navicular, which are well accommodated with articular facets on the distal extremities of the three bones in question, so that their identification as the three cuneiforms, is probably necessary. The two remaining metatarsals are articulated, the fourth to the exterodistal facet of the cuboid; and the fifth to the exterior side of the cuboid. The third, fourth and fifth metatarsals are directed at an obtuse angle posteriorly from the long axis of the astragalus.

This structure is more mammalian than any form of foot yet known among reptiles, and agrees with the indications of mammalian character described as existing in the long bones of the limbs by Owen and by myself.

. The astragalus is an oblong bone with one long straight side, viz., that which is in contact with the calcaneum. This side has two facets for articulation with the calcaneum, which are separated by a groove, which forms a foramen when the two bones are in place. The proximal extremity of the bone is much smaller than the distal, and is subround. The proximal half of the bone would be nearly cylindric were it not for the truncation caused by the calcaneal facet. The distal half of the bone is robust, and is surrounded on all sides by facets. These are the external or calcaneal, the distal or navicular, and the internal which is larger than the other two together. The first two are oblong and truncate, the navicular twice as large as the calcaneal, its transvere much exceeding its anteroposterior diameter. The internal facet already mentioned, covers the internal face of the distal half of the astragalus, which projects further inwards than the proximal half, rising abruptly from it. The facet is continuous with the navicular, and is at right angles to its plane. It widens proximally, and its proximal border is deeply notched. Its surface is convex from back to front, but not strongly so. In the astragalus of a species of Dimetrodon, it is divided by an angle into two facets, the two faces thus produced being nearly at right angles to each other. This inferior part of the facet is continued into a prominent border which is more or less roughened. A rounded tuberosity of the inferior face of the bone occupies the space between this border and the calcaneal border, so approaching the notch already described, as to cause a groove to proceed from it posteriorly and inwards. I described the corresponding bone in the *Clepsydrops collettii* (Proceeds. Phila. Academy, 1875, p. 409) as a possible coracoid.

The calcaneum has its postero-external edge broken in the specimen of *Clepsydrops natalis* described, but is probably a semidiscoid bone, with its straight margin applied to the astragalus. This margin presents a median flat elongate-oval facet, which is separated by grooves from a facet at each end. The proximal facet is the narrower, and passes by a curve into the proximal extremital facet, which is adjacent to the corresponding proximal facet of the astragalus. The distal internal facet is triangular and wider

than long, and is separated by an angle only from the distal facet. The latter is a little more than a half circle in outline, and joins one bone of the second row, which I suppose to be the cuboid. The fact that it does not articulate with the second element in that row, leads me to suspect that the latter is the head of a fifth metatarsal. The external edge of the bone thins out more rapidly at the distal than at the proximal extremity.

The cuboid bone is pentagonal in outline, and square in transvere section. It is not unlike that of the Amblypodous Mammalia. It has a transverse proximal facet, and two distal ones which meet at an angle about right. The fifth metatarsal is articulated with its posterior face; and the fourth with the exterior distal face. The ectocuneïform articulates with the interior distal face. The navicular bone is subtriangular in transverse section, and with a subquadrate base articulating with the cuboid. Its longitudinal and anteroposterior diameters are about equal. The distal or metatarsal articulation of the entocuneïform is transverse and flat.

The manner of articulation of the ankle-joint must have been different from the usual reptilian type. The proximal extremities of the astragalus and calcaneum combined are not too large to have received the distal extremity of the fibula, so that the tibial articulation must be sought elsewhere. This may have been on the large distal facet of the anterior or inner face of the bone. A part of this facet looks upwards and probably supported the tibia, which was thus removed by a short space from that of the fibula. The down-looking part of the facet, which is more distinct in Embolophorus, must have articulated with a separate element. This may have been a spur, such as exists in the known genera of the Monotremata; as the position is identical with that which bears this appendage in those animals. It is quite evident that an element additional to those known in the ordinary reptilian foot exists in the Clepsydropidæ.

The separation of the distal extremities of the tibia and fibula is not usual among reptiles, but it is common in the salamanders, where the os centrale comes between them. It is also evident that the subcylindric proximal part of the astragalus, which intervenes between the supposed tibial and fibular articulations, represents that bone.

The metatarsals are directed obliquely backwards as well as outwards, as in Tachyglossus and Platypus.

The following results may be derived from the preceding statements: (1) The relations and number of the bones of the posterior foot are those of the Mammalia much more than those of the Reptilia. (2) The relations of the astragalus and calcaneum to each other are as in the Monotreme *Platypus anatinus*. (3) The articulation of the fibula with both calcaneum and astragalus is as in the Monotreme order of mammals. (4) The separate articulation of the anterior part of the astragalus with the tibia is as in the same order. (5) The presence of a facet for an articulation of a spur is as in the same order. (6) The posterior-exterior direction of the digits is as in the known species of Monotremata.

Thus the characters of the posterior foot of the Pelycosauria confirm the

evidences of Monotreme affinity observed by Professor Owen and myself in the bones of the legs, especially of the anterior leg. It remains a fact that with this resemblance in the leg there is a general adherence to the reptilian type in the structure of the skull. But this adherence is not so exclusive as has been supposed, as I will now endeavor to show.

THE STRUCTURE OF THE COLUMELLA AURIS IN CLEPSYDROPS LEPTOCEPHALUS.—As already briefly described above, this element is bifurcate at the proximal extremity. The shorter expanded extremity is the stapes proper. The oblique perforation of its base is a character which has not been hitherto observed in any reptile, not even in the allied form Hatteria (Huxley). If, as is probable, the perforation is homologous with the foramen of the mammalian stapes, we have here another point of resemblance to this class. The longer proximal branch of the columella has only half the width of the stapedial portion; and its long axis makes an obtuse angle with that of the latter. It is perhaps the ossified suprastapedial cartilage of Huxley, which that author states (Anatomy of Vertebrated Animals, p. 77) is not ossified in any of the living Sauropsida. Huxley supposes this cartilage to be the homologue of the incus, and remarks * that in a young Mammalian fœtus "it appears exactly as if the incus were the proximal end of the cartilage of the first visceral arch." The columella now described resembles a rib, of which the suprastapedial process resembles the head, and the stapes the tubercle. If this process be the incus, the stapes is shortened as in the majority of Mammalia, unless the primitive suture between the two be longitudinal. The form and position of the true stapes give support to the view of Salensky, that it is not part of a true visceral arch, but is developed in the connective tissue surrounding the mandibular artery. We see that in this Pelycosaurian it is not the proximal part of the arch, and surrounds the mandibular artery. The columella is divided into at least two distinct elements. This is clearly indicated by its abrupt truncation distally by a rough sutural surface. If there is but one bone distad to the stapes, it is homologous with the cartilage, which has been shown by Peters † to be distinct in Hatteria, crocodiles and various lizards. It is the triangular ligament of Cuvier. If the suprastapedial be incus, this element is malleus; and it is usually identified as such by the older anatomists. In this structure we have evidence that the hypothesis that the articular and quadrate bones are homologous with the ossicula auditus is incorrect. The Pelycosauria will probably come under the head of "Sauropsides malleoferes" of Albrecht. We have here an approximation to the Mammalia in two points: (1) The perforation of the head of the stapes; (2) and the ossification of the incus, which (3) is distinct from the malleus, thus furnishing homologues of the principal ossicles of the ear. It

* Proceedings Zool. Society, London, 1869, p. 391.
† Monatsberichte der Academie Sciences, Berlin 1868 (p. 592)—1870.

is unnecessary to observe however, that this part of the skeleton does not resemble the corresponding part in the known Monotremes.

STRUCTURE OF THE QUADRATE BONE IN THE GENUS CLEPSYDROPS.—The quadrate bone in *Clepsydrops leptocephalus* Cope, already described, is of highly interesting form. It consists of two portions, a vertical and a transverse, the latter much longer than the former. The vertical portion is wedge-shaped with the base fashioned into the condyle for the mandibular ramus. Its posterior face to the apex, is articulated with the large squamosal, which rises towards the pariëtal bone. The distal part of the quadrate is grooved anteriorly, and each edge sends a process forwards. The internal is short, and articulates with the pterygoid. The external is the long horizontal part of the bone already mentioned. It is compressed, and at the end is acuminate. Although the malar bone is out of place in the specimen described, examination of the skull of the *Clepsydrops natalis*, where it is preserved in position, shows that this horizontal ramus of the quadrate is nothing more than the zygomatic process of the squamosal bone of the Mammalia, forming with the malar bone the zygomatic arch. *In the Pelycosauria there is but one posterior lateral arch*, as is demonstrated by many specimens ; hence, we have here a reptile with a zygomatic arch attached to the distal extremity of the quadrate bone.

Important results follow this determination. We have seen that, with Peters, we need no longer look to the auricular chain of ossicles, and especially to the incus, to find the homologue of the os quadratum of the Vertebrata below the Mammalia. According to Albrecht *the os quadratum is the homologue of the zygomatic portion of the squamosal bone.* If this be true, in the process of specialization of the reptiles, the anterior or zygomatic portion of the quadrate has been lost or separated as a quadrato-jugal bone, and the condylar portion extended, until it has reached the extreme length we observe in snakes. This determination of the character of the quadrate bone in the Theromorphous Reptilia is confirmatory of the theory broached by Albrecht.* Among many propositions novel to the science of osteology, none has been more unexpected than his assertion that the quadrate bone is the homologue of the zygomatic and glenoid portion of the squamosal bone of Mammalia. This is in contradiction to the view held by many comparative anatomists from the day of Reichert to the present time.

I made a study of these arches several years ago, which is published in the Proceedings of the American Association Adv. Science, Vol. xix, p. 18. Accepting the prevailing view that the quadrate bone is one of the auditory ossicles, I naturally homologized the superior arch of the reptilian skull, which articulates with the squamosal proper, with the zygomatic arch, and looked upon the quadratojugal arch as an additional structure, connected with the peculiar development of the supposed incus.

* Sur la valeur morphologique de l'articulation mandibulaire et des osselets de l'oreille, etc.; Bruxelles, Mayolez, 1883.

Should Albrecht's determination of the homology of the quadrate bone prove to be correct, the quadratojugal arch is the zygomatic, and the superior arch becomes the accessory one. This being admitted, the Lacertilia cannot be said to have a zygomatic arch, and the Theromorpha do not possess their postorbito-squamosal arch; the diversity between the two orders being thus greater than has been supposed.

THE ARTICULATION OF THE RIBS IN EMBOLOPHORUS.—The ribs of the Theromorpha are two-headed. While the tubercular articulation has the usual position at the extremity of the diapophysis, the capitular is not distinctly, or is but partially indicated, on the anterior edge of the centrum, in Clepsydrops and Dimetrodon. In Embolophorus, as I showed in 1869, the capitular articulation is distinctly to the intercentrum. A second and larger species of that genus, recently come to hand, displays this character in a striking degree, since the intercentrum possesses on each side a short process with a concave articular facet for the head of the ribs. From the slight corresponding contact with the intercentrum seen in Dimetrodon and other genera, there can be little doubt that this is the true homology of the ribs in the order Theromorpha.

The consequence follows from this determination, that the ribs of this order are intercentral and not central elements, and that they do not therefore belong to the true vertebræ, thus agreeing with the chevron bones, with which they are homologous.

It is also true that this type of rib-articulation *approximates closely that of the Mammalia*, where the capitular articulation is in a fossa excavated from two adjacent vertebræ. This is what would result if the intercentrum were removed from a Theromorph reptile, and the head of the rib allowed to rest in the fissure between the centra left by the removal. It is well known that the double rib articulation of the other reptilian orders which possess it, viz.: Ichthyopterygia, Crocodilia, Dinosauria and Pterosauria, and in the birds, is different, the capitular connection being below the tubercular, on the centrum. Whether the capitular articulations and the ribs in these orders are homologous with those of the Theromorpha, remains to be ascertained,

THE ORIGIN OF THE MAMMALIA.—The relation of the characters of the Pelycosaurian suborder of the Theromorpha to those of the Mammalia may now be seen to be very important. I give a synopsis of the characters of these divisions parallel with those of the Batrachia contemporary with them, in order to give a clear idea of the reasons for believing that *the Mammalia are the descendants of the Pelycosauria.*

The following table shows that the Mammalia agree with the Batrachia n two and part of another character; with the Pelycosauria in six characters, and with other Reptilia in two characters. The Pelycosauria agree with the Batrachia in two and in parts of two other characters, and with other Reptilia in three characters, two of which (Nos. 2 and 3) are of prime importance. Of the characters in which the Pelycosauria agree

	Batrachia.	Pelycosauria.	Other Reptilia.	Mammalia.
1. Basicranial axis,	Unossified and with a parasphenoid.	Ossified; no parasphenoid.	Ossified; no parasphenoid.	Ossified; no parasphenoid.
2. Occipital condyle,	Two.	One.	One.	Two.
3. Quadrate bone,	Separate.	Separate.	Separate.	"Coössified with squamosal."—(Albrecht.)
4. Postorbitosquamosal arch,	Present (in Permian forms).	Wanting.	Present (generally).	Wanting.
5. Coracoid bone,	Small, coössified.	Small, coössified.	Large, distinct.	Small, coössified.
6. Ribs,	Diapophysial.	Intercentral.	Diapophysial and central (in position).	Intercentral.
7. Pelvis,	Without obturator foramen.	Without obturator foramen.	With obturator foramen.	With obturator foramen.
8. Posterior foot,	Intermedium, tibiale, fibulare and centrale distinct.	Tibiale, fibulare and centrale distinct; intermedium united with tibiale.	Intermedium, and centrale not distinct; tibiale and fibulare generally not distinct.	Tibiale, fibulare and centrale distinct; intermedium united with tibiale.
9. Humerus,	With condyles.	With condyles and epicondylar foramen.	No epicondylar foramen rarely condyles.;	Condyles; frequently epicondylar foramen.

with the Mammalia, two are of first class importance (Nos. 1 and 5); three are of great but unascertained degree of importance (Nos. 4, 6 and 8), and one (No. 9) is of less importance. The two characters (Nos. 2 and 5) in which the Mammalia agree with the Batrachia, are of high importance, but one of them is also a point in which the Pelycosauria agree with both (structure of the coracoid bone, No. 5). There is but one character, the distinctness of the quadrate bone, in which the Batrachia agree with the Reptilia in general.

The preceding comparison renders it extremely probable that the Mammalia are descended from the Pelycosaurian Reptilia. The usual definitions have been invalidated, excepting that of the occipital condyles, but even this is not so absolute a character as has been supposed. In the gecko lizard, Uroplates, the occipital condyle is represented by the exoccipital pieces only, the basioccipital element being omitted nearly as in the Mammalia. Professors Huxley and Parker have declared it as most probable that the true ancestor of the Mammalia have been the Batrachia. It is evident that the Pelycosauria are in various respects the most Batrachian of the Reptilia, for they agree with them in three and parts of two other characters of the nine above enumerated. One of the latter is the structure of the posterior foot, which displays much less modification from the Batrachian type than that of the ordinary Reptilia.

The first evidence of the resemblance of the Pelycosauria to the Mammalia was empirical and not conclusive. This consisted in the characters derived from the long bones of the limbs. Professor Owen first called attention to this resemblance in the genus Cynodraco, which is a Theromorph reptile. I next pointed out corresponding peculiarities in the humeri of the American Theromorphs. I subsequently showed the resemblance between the pelvis of the Pelycosaur division, and that of the Monotremata. This was followed by a demonstration of the resemblance between the coracoid of the Pelycosauria and the Mammalia of the Monotrematous order, especially the family of the Platypodidæ. The present article now adds that the structure of the posterior foot approaches near to that of the Monotremata; and that the os quadratum and the ribs are essentially like the corresponding parts in all the Mammalia. The last three points are essential and fundamental. The three great distinctions between the Mammalia and Reptilia in the skeleton are: (1) in the quadrate bone; (2) in the coracoid bone, and (3) in the occipital condyle. Of these the last only now remains, and this is weakened by the presence of the Mammalian type in the geckotian lizard already referred to. The only interruption in the series which has not yet been overcome is in the columella auris. No reptile is yet known where that element is divided into incus, orbicularis, and stapes, as in the Mammalia and some Batrachia (according to Albrecht). Of course the above comparison with the Monotremata considers the latter order in its proper ordinal definitions, and not in its special subordinate modifications now existing, the Platytidæ and Tachyglossidæ. Monotremata dentition like that of the known Jurassic and Triassic Mammalia will doubtless yet be discovered in beds of those ages.

As this paper goes to press, the interesting announcement made at the meeting of the British Association for the advancement of science at Montreal may be referred to. Mr. Caldwell, the holder of the Balfour scholarship, telegraphs that he has discovered that the *Platypus anatinus* is oviparous, and that the egg is meroblastic. This confirms the hypothesis of descent from reptilian ancestors rather than Batrachian. Haeckel gives the segmentation as meroblastic, Studien zur Gastræa Theorie, Jena, 1877, p. 65.

NOTE ON THE TARSUS.—I am just in receipt of an MS. from Dr. Baur, of New Haven, in which he presents an identification of the "internal navicular" bone of some rodents, and which probably existed in the ungulate genera Pantolambda and Bathmodon. He identifies it with the tibiale, and denies that the astragalus includes that element, but that it consists wholly of the intermedium. This identification will also apply, though Dr. Baur in his manuscript does not make it, to the element which supports the spur in the known Monotremata. It will also explain the nature of the element which occupies the same position in the foot of the Pelycosauria above described. The arrangement in this order of reptiles confirms the conclusion reached by Dr. Baur, since the questionable element is here in direct contact with the tibial facet of the astragalus.

NOTE ON PHYLOGENY OF the VERTEBRATA.—As my researches have now, as I believe, disclosed the ancestry of the Mammals,* the birds,† the reptiles, and the true fishes,‡ or Hyopomata, I give the following phylogentic diagram illustrating the same. This will only include the leading divisions. The special phylogenies of the Batrachia ‖ and Reptilia,§ and some of the Mammalia ¶ have been already given.

The Mammalia have been traced to the Theromorphous reptiles through the Monotremata. The birds, some of them at least, appear to have been derived from the Dinosaurian reptiles. The Reptilia in their primary representative order, the Theromorpha, have been probably derived from the Rhachitomous Batrachia. The Batrachia have originated from the subclass of fishes, the Dipnoi,‡ though not from any known form. I have shown that the true fishes or Hyopomata have descended from an order of sharks,‡ the Ichthyotomi, which possess characters of the Dipnoi also. The origin of the sharks remains entirely obscure, as does also that of the Marsipobranchi. Dohrn ** believes the latter class to have acquired its

* American Naturalist, 1884, p. 1136.

† Proceedings Academy Philadelphia, 1867, 234.

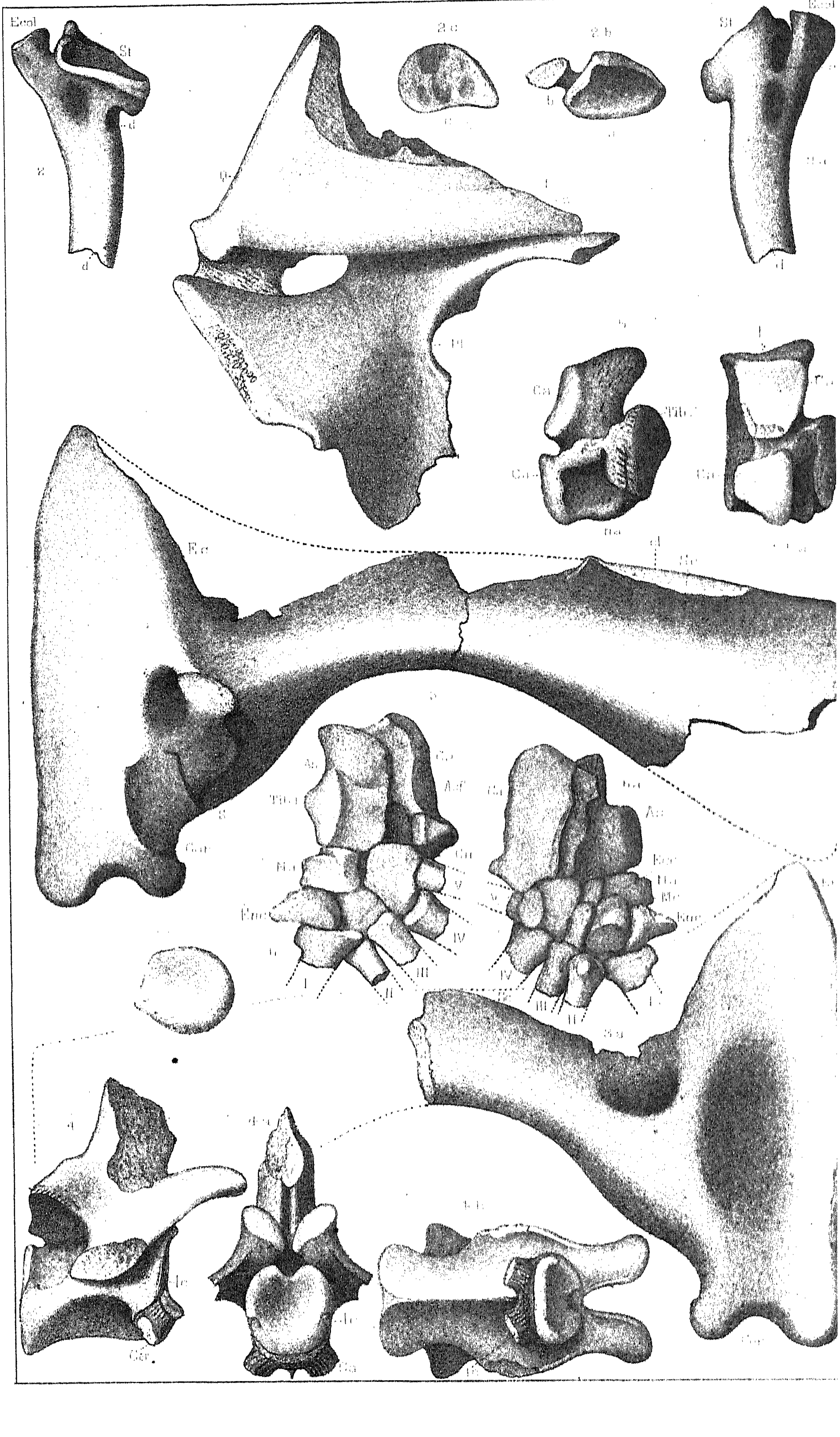
‡ Proceedings American Philosophical Society, 1884, p. 585.

‖ American Naturalist, 1884, p. 27,

§ Proceedings American Association for the Advancement of Science, xix, 1871, 233.

¶ Proceedings American Philosophical Society, 1882, 447; American Naturalist, 1884, p. 261 and 1121. Report U. S. Geol. Survey W. of 100th Mer., G. M. Wheeler 1877, iv, ii, p. 282.

** Der Ursprung der Wirbelthiere u. d. Princip des Functionwechsels, von Anton Dohrn, Leipsic, 1875, p. 82.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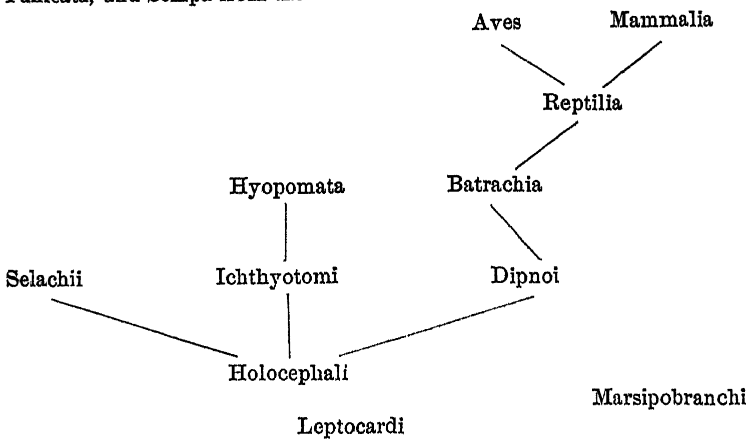
present character by a process of degeneration. The origin of the Vertebrata is as yet entirely unknown, Kowalevsky deriving them from the Tunicata, and Sempa from the Annelida.



EXPLANATION OF PLATE.

Fig. 1. *Clepsydrops leptocephalus* Cope, right quadrate bone (Q) with condyle and zygomatic process (*z*) from the right, or external side *Pt*, pterygoid bone of same side displaced so as to be in plane of quadrate, and to be seen from inferior side. One-half natural size.

Fig. 2. Columella auris of the individual of *Clepsydrops leptocephalus* represented in fig. 1; internal side. Fig. 2*a* external side; 2*b* proximal extremity; 2*c* distal extremity; *s*, head of stapes; Ecol. epicolumella; *d*, distal articular surface, especially represented in fig. 2*c*. All figures are half natural size, excepting 2*c*, which is natural size.

Fig. 3. Left half scapular arch of a Pelycosaurian, less clavicle and episternum, one-half natural size. *sc*, scapula; *cl*, facet for clavicle; *cor.* coracoid; *ec*, epicoracoid; *s*, open suture between coracoid and epicoracoid, indicating the immaturity of the animal.

Fig. 4. Dorsal vertebra of a species of Embolophorus, one-half natural size; right side; *a*, from front; *b*, from below; *ic*, intercentrum; *ca*, capitular rib articulation.

Fig. 5. Astragalus of individual figured in fig. 4, one-half natural size; from below. *ca*, *ca*, facets for calcaneum; *na*, do. for navicular; *tib*, 2, do. for bone of spur, or os tibiale. 5*a*, same bone from external or calcaneal border; *f*, fibular facet. 5*b*, same bone, proximal or fibular extremity.

Fig. 6. Left posterior foot of *Clepsydrops natalis* Cope, superior side, and 6*a*, inferior (plantar) side, two-thirds natural size. *as*, astragalus; *ca*, calcaneum; *na*, navicular bone; *cu*, cuboid; *euc*, *mc* and *ecc*, entocuneïform, mesocuneïform and ectocuneïform bones, respectively. I, II, III, IV, V, metatarsals. *Tib* 1, Probable tibial facet. In this specimen the calcaneum is displaced; being turned backwards, so as to present its two astragalar facets (*asf*) anteriorly.

Andrew Atkinson Humphreys, Brigadier-General U. S. Army, Brevet Major-General U. S. Army, Chief of Engineers. By Hampton L. Carson.

(Read before the American Philosophical Society, Dec. 5, 1884.)

The life of Andrew Atkinson Humphreys was one of reflection and action, of incident and character. A man of science, a brilliant soldier, an accomplished scholar, a polished gentleman, the lineal descendant of distinguished men, and the inheritor of their talents and virtues, he displayed in every walk of life the highest qualities, and combined the most opposite characteristics. Born to command, he easily attained the front rank in every species of labor which he undertook, yet his modesty was as great as it was rare. His intercourse with men was graced by a charm of manner, a simplicity of diction, a purity of sentiment, a gentle resistlessness of will that armed him with a power which few could oppose with success; or if, misled by these, they had dared to stir the half-hidden fire of his nature, they would have found him as terrible as Saul. Whether we view him as an engineer, investigating the destructive dynamics of our floods, and demonstrating the laws by which they are governed; or as a division commander leading his troops to the fierce assault, and animating them by his personal example; or as the chief of staff of the commander of a great army, sagacious, practical and fertile in resources; or as a corps commander, skillful and intrepid; or as the chief of engineers, broad-minded and profound; or as a military writer, luminous yet terse, we find his career marked with capacity, energy, and success. As Sallust said of Jugurtha, he was, indeed, both brave in action and wise in council; qualities very seldom united in the same person, precaution being generally accompanied with timidity, and courage with rashness. The most conspicuous of his virtues were truth, integrity and honor. A devoted husband, a tender father, an affectionate brother, a generous and unflinching friend, with a chivalrous regard for woman worthy of the best days of heraldry, he was in public and in private, a man to be feared, to be trusted, to be admired, to be loved; a man with whom no one could trifle, and whom no one would care to offend.

The name of Humphreys is of Norman origin, and can be traced for a thousand years. It occurs in Doomsday book as Humfridus—subsequently spelled as Humfrey or Humphry—and six coats-of-arms, all very ancient, appear to have been brought into the Herald's office in 1340, upon its first establishment.* The crest of one branch of the family—a lion with his dexter paw upon a nag's head—refers most probably to the conquest of Wales, where the sturdy victors dwelt upon the lands of which they gat possession through their swords. Here they remained for seven hundred

*See Marshaling and coat-of-arms presented to Gen. David Humphreys, LL.D., by Ozias Humphreys, artist, of London, about 1790; preserved among his papers and presented by the widow of William Humphreys, nephew of Gen. David Humphreys, to Dr. Frederick Humphreys in 1863. Illuminated copy of the coats-of-arms of the Humphreys family in possession of the writer.

years, when one of their number, Daniel Humphreys, of Porthwen, Merionethshire, Wales, came to Pennsylvania in 1682, and settled in Haverford township, now of Delaware county, about seven miles west of Philadelphia, and was followed the next year by his mother Elizabeth, the widow of Samuel Humphreys, with her younger children.* He had joined the Friends in his native country, "and left such a testimony behind him as is and was of good savor."† In 1695 he was married to Hannah, the daughter of Dr. Thomas Wynn, of Merion. They had many children, among whom were Joshua, Edward and Charles. Joshua was the great-grandfather of the subject of this sketch. Edward acquired a high reputation as a physician and surgeon, and was beloved for his benevolence and humanity. Charles Humphreys was a man of fine talents, and of great influence in the county. In 1764, he was elected to the Provincial Assembly, and was reëlected annually to that office, until 1775, when he was chosen a member of the Continental Congress. In that body he contended with energy against the oppressive measures of Great Britain, but, fettered by his oath of allegiance, and by what he believed to be the views of a large majority of his constituents, he voted with John Dickerson, Thomas Willing, Edward Biddle, and Andrew Allen, against the Declaration of Independence. He then retired to private life, and though sympathizing with his country, took no part in the struggle.‡

Joshua Humphreys, the son of Joshua, and grandson of Daniel Humphreys, the immigrant, was the grandfather of Andrew Atkinson Humphreys. He was born in Haverford township in the year 1751. His mother was Sarah, the daughter of Edward and Elinor Williams, of Blockley. His ancestors were thoroughly Welsh, and all of them Quakers. With only the advantages of such an early education as the common schools of the country afforded at that day, Joshua was apprenticed at a tender age to a ship carpenter of Philadelphia. Before the completion of his apprenticeship his instructor died, and he was at once placed at the head of the establishment, and managed the business for the widow for several years with prudence and success. Possessing a comprehensive and philosophical mind, he soon came to be regarded as the first naval architect in the country. Such was his eminence, that after the adoption of the Constitution of the United States, and when it became apparent that our Government must have a navy, Mr. Humphreys was consulted, offi-

* Elizabeth Humphreys and her children were all Friends. She brought a certificate with her that recommends her "for an honest, faithful woman yt has been serviceable in her place, and praiseworthy in her conversation," and her children "as tender plants growing in that which they do profess, even the truth and Grace of God." Copy of original certificate in possession of the widow of Gen. A. A. Humphreys, Smith's History of Delaware County, Pennsylvania, p. 471.

† Biographies of early settlers and eminent men of Delaware county. History of Delaware County, Pennsylvania, by George Smith, M.D., p. 471.

‡ Centennial collection. Charles Humphreys. The Pennsylvania Magazine of History and Biography, Vol. I, p. 83. Smith's History of Delaware County, p. 472.

cially, and his views, which had been communicated to the Hon. Robert Morris, in a letter dated January 6th, 1793, but more in detail to Gen. Knox, then Secretary of War, were, in the main, adopted. He was the first naval constructor of the United States, and several of our first ships of war, the *Constitution*, the *Chesapeake*, the *Congress*, the *Constellation* and the *President* were built according to his plans, and the *United States* was built at his own yard under his immediate direction.* These were the famous ships whose marvelous success may be gathered from the annals of the naval warfare with Tripoli in 1804 and with Great Britain in 1812.†

Very justly Mr. Humphreys has been called the Father of the American Navy. The last thirty years of his life were spent in quiet retirement on a part of his patrimonial estate, Ponte-Reading, in Haverford. Here he died in 1838, at the advanced age of eighty-seven years, with mental faculties unimpaired.

Samuel Humphreys, a son of Joshua, was educated by his father as a naval constructor, and some of the most beautiful ships in our navy were from his models.‡

In 1813 he was appointed naval constructor for the Philadelphia Navy Yard, and, in 1826, by President John Quincy Adams, Chief Naval Constructor of the United States, a position which he held until his death in 1846. One incident in his career deserves to be narrated. When Izakoff, a special ambassador, who had been sent to America by the Emperor Alexander, with authority to engage the best shipbuilding talent for the construction of a Russian navy, sought to fulfill the imperial instructions, he sent, through Mr. Richard Peters, for "Sam. Humphreys." He offered him a salary of $60,000 per annum, a town house and a country residence

* The Lives of Eminent Philadelphians, now deceased, p. 588.
Naval History of the United States, by J. Fenimore Cooper, Vol. i, p. 149.
American State Papers. Vol. i, p. 402.
The Commencement of the United States Navy, 1794, by Rear Admiral George H. Preble, The United Service, February, 1884, pp. 139–149.

† The main idea of Mr. Humphreys was that the ships should be heavier in tonnage and artillery than their rates would seem to authorize; they proved fast sailers, capable of enduring heavy battering, and of inflicting severe injuries in a short space of time. So terrible was their armament that the British termed them "74's in disguise."

‡ Clement Humphreys, the eldest son of Joshua, gave evidence, when a mere lad, of spirit and daring. Infuriated over an attack in the columns of the *Aurora* upon the Federalists and upon the late President Washington, on the 4th of April, 1797, he violently assaulted the editor, who was visiting the frigate, the *United States*, then on the stocks at Philadelphia. He was tried for assault and battery and convicted, and was fined $50, and ordered to give security in the sum of two thousand dollars to keep the peace. Such was the admiration of his conduct on the part of the Federalist merchants of the city that they paid the fine and furnished the security. President Adams subsequently sent him to France with special despatches—a reward, as hostile critics asserted, for having thrashed a Republican.

The Aurora, General Advertizer, Philadelphia, April 6, 1797. History of Philadelphia, by Thompson Westcott, Chap. cccxxxiii. Hildreth's History of the United States, second series, Vol. ii, p. 44.

to be maintained by the Czar, horses and coaches, and servants, and if these were insufficient, he could name his own terms. After a day's consideration, Humphreys replied: "The salary is greater than I could earn; more than I need; more than I want; more than I could use. As to the town house and country-house, I need but one, and that should be near my business. As to the coaches and servants, I always walk and wait upon myself, and should find myself unable to govern a multitude of servants. I do not know that I possess the talents my friend, Mr. Peters, ascribes to me; but I do know and feel that, whether my merit be great or small, I owe it all to the flag of my country, and that is a debt I must pay." *

In the history of refusals of dazzling offers, where can the parallel of this instance of lofty patriotism be found?

Such a man was the father of Andrew Atkinson Humphreys.

The maternal grandfather of General Humphreys, and for whom he was named, was Andrew Atkinson, of Prehend Caven-Garden, Ireland, and his maternal grandmother was Jane Murray, the daughter of Sir Archibald Murray, the descendant of that Murray of Black Barony, in Scotland, who espoused the cause of the Pretender. The story runs that Andrew Atkinson, then a gallant ensign in the British army, of nineteen years of age, first saw Jane Murray, a beautiful girl of sixteen, on the battlements of Edinburgh Castle, and, captivated by her charms, gracefully lowered his colors as he passed. He sought and obtained an introduction, which resulted in their elopement and marriage. He subsequently purchased a plantation in Florida, upon the St. John's river, and after the cession of Florida by Spain, came to Philadelphia, where he died. His daughter, Letitia Atkinson, met Samuel Humphreys at Dungeness, the house of the widow of General Nathaniel Greene, upon Cumberland Island, Georgia, whither he had been sent, as a youth of eighteen, to inspect live-oak timber for the great battle ships, and the meeting led to their marriage. They had eight children, of whom Andrew Atkinson Humphreys was the second son.

I have dwelt at length upon the ancestry of General Humphreys, because in the analysis of his character it is interesting to trace to their source his many admirable traits.† The blood of Normandy, Scotland, Ireland and Wales was commingled in his veins, an apt admixture for the production of thorough manliness. From his father's side he inherited his dauntless spirit, his inflexible resolution, his spotless integrity, his partiotism and great philosophical powers of mind. From his mother, who was a woman of loveliness and grace, his exquisite charm of manner, his strict self-control, his unwillingness to believe evil report of any one, his

* Samuel Humphreys, Chief Naval Constructor of the United States, The Pennsylvania Magazine of History and Biography, Vol. viii, p. 216.

† Mr. Galton, in his work on Hereditary Genius, marshals an imposing array of evidence in support of his proposition, that genius, talent or whatever we term great mental capacity, follows the law of organic transmission—runs in families, and is an affair of blood and breed.

readiness to admit of every palliation of bad conduct, without any weakness or credulity of judgment, and his exalted admiration of woman. His nature responded to his mother's gentlest touch, and she always spoke of him as "my sympathizing child."

Andrew Atkinson Humphreys was born in the city of Philadelphia, November 2, 1810. As a boy, he was fearless, upright and honorable, with a determined spirit of resistance to anything like tyranny or personal affront; first in all manly sports and a leader in daring exploits. His early education was received at "Tommy Watson's," the Germantown Academy, and the school of an Englishman named Warren, who unfortunately used the rod. To the indignity of personal chastisement young Humphreys was too spirited to submit, and no command, entreaty or persuasion could induce him to return to the school, though the teacher himself called upon his parents, regretting the loss of a pupil of talents and ability, and promising an entire change of treatment. He then went to the Moravian school for boys at Nazareth, Pennsylvania. In after life he frequently alluded with emotion to the happy days spent at the latter institution, where he said he imbibed a taste for reading and music. Subsequently, he had a private tutor, and in his seventeenth year went to West Point, July 1, 1827; was graduated thirteenth in a class of thirty-three, July 1, 1831, and was assigned to the Second Artillery, with the rank of Brevet Second Lieutenant. Among his classmates were Roswell Park, Henry Clay, a son of the distinguished statesman, George Turner, Samuel C. Ridgeley, George H. Talcot, William H. Emory, William Chapman, Thomas McKean, Henry Van Rensselaer, Edward Ogden, Samuel G. Curtis, and James Williams.*

He served in garrison at Fort Moultrie, S. C., in 1831; was assigned to temporary duty at the United States Military Academy in 1832; to the Cherokee Nation in 1832 and 1833; and to Augusta Arsenal, Ga., and Fort Marion, Fla., 1833 and 1834. He was on Topographical duty, making surveys in West Florida and at Cape Cod, Mass., in 1834 and 1835, and participated in the Florida war against the Seminole Indians in 1836, being engaged in the action of Oloklikaha, March 31, 1836, and the action near Micanopy, June 9, 1836.

On September 30, 1836, he resigned his commission as an officer of the United States Army, and during the years 1836–'38, as Civil Engineer, assisted the late General Hartman Bache on the plans of Brandywine Shoal Lighthouse and Crow Shoal Breakwater, Delaware bay.

Upon the re-organization of the Corps of Topographical Engineers in 1838, General Humphreys was re appointed in the Army, with the rank of First Lieutenant in that Corps.

He served in charge of works for the improvement of Chicago harbor, Ill.; as Assistant Topographical Engineer of survey of Oswego harbor defences, N. Y., and in charge of survey of Whitehall harbor, N. Y., in

* Class of 1831, Cullum's Biographical Register of the Graduates of West Point.

1839; as Assistant in the Topographical Bureau at Washington, D. C., 1840–'41; in the Florida war, 1842; on construction of bridge at Washington, D. C., 1842; as Assistant in Topographical Bureau at Washington, D. C., 1842–'43–'44; as Assistant in charge of the Coast Survey Office at Washington, D. C., 1844–'49, and on surveys in the field, 1849–'50.

He was engaged in making a Topographic and Hydrographic survey of the Delta of the Mississippi river, with a view to its protection from inundation, and deepening the channels at its mouth, 1850–'51, continuing in general charge of the work and preparing his able and voluminous report thereon, till 1861. In 1853 he was sent on special duty to Europe to examine means for the protection of delta rivers from inundation. He was in general charge, under the War Department, of the office duties at Washington, D. C., connected with the explorations and surveys for railroads from the Mississippi river to the Pacific ocean, and geographical explorations west of the Mississippi river, from 1854 to 1861, and was a member of the Lighthouse Board, from 1856 to 1862; of the Board "to revise programme of instruction at the United States Military Academy," and of the Commission created by act of Congress "to examine into the organization, system of discipline, and course of instruction at the United States Military Academy, 1860."*

It would be difficult to overestimate the value and extent of the labors of General Humphreys in the field of science. I can dwell only upon his greatest work: *The Report upon the Physics and Hydraulics of the Mississippi River; upon the Protection of the Alluvial Region against Overflow; and upon the Deepening of the Mouths; Based upon Surveys and Investigations, made under the Acts of Congress directing the Topographical and Hydrographical Survey of the Delta of the Mississippi River, with such Investigations as might lead to determine the most Practicable Plan for Securing it from Inundation, and the best mode of Deepening the Channels at the Mouths of the River.*†

The title but feebly suggests the vast scope of the work.

The Mississippi river, below the mouth of the Missouri, changes its character from a gentle current and a clear tide to a turbid, boiling torrent, tremendous in volume and force. Thenceforth, for thirteen hundred miles, it pursues a devious course, washing away banks and islands here, rebuilding them there, absorbing tributary after tributary, until at last it is itself swallowed up in the greater volume of the Gulf. Just above the mouth of the Ohio begins a great alluvial plain, some fifty miles in

* Statement of Services of Brigadier-General Andrew A. Humphreys, Corps of Engineers, Brevet Major-General U. S. A. General Orders, No. 10, Headquarters Corps of Engineers, U. S. A., Washington, D. C., December 20, 1883.

† Submitted to the Bureau of Topographical Engineers, War Department, 1861. Prepared by Captain A. A. Humphreys and Lieutenant H. L. Abbot, Corps of Topographical Engineers, United States Army. Philadelphia: J. B. Lippincott & Co. 1861. 4to, pp. 456; with an Appendix, pp. 146, and 20 plates. Reprinted, with Additions, in 1876.

width, which is mostly below the level of the floods. In extent the valley of the Mississippi is equal in surface to all Europe, except Russia, Norway and Sweden. It has no topographical obstructions. It contains immense navigable rivers, and is connected with vast inland seas. A great historian, with the inspiration of a prophet and the fire of a poet, has predicted that "with such a varied and splendid entourage—an imperial cordon of States—nothing can prevent the Mississippi valley from becoming in less than three generations the centre of human power."* The problem of protection against overflow is the great practical question involving the prosperity of that entire region. Millions of dollars had been fruitlessly expended by the States of Louisiana, Arkansas and Missouri, through want of concert, want of knowledge and misdirected and divided effort. Politics, too, embroiled the results, so that when, in September, 1850, the Federal Government granted to the several States bordering on the river all the swamp and overflowed lands within their limits, remaining unsold, in order to provide a fund to reclaim the districts liable to inundation, the planters in the lower valley of the river, alarmed lest the effect of the reclamation of vast swamps above should tend to increase the floods below, invoked the aid of the General Government in the necessary surveys for investigating the matter. From this movement the Delta Survey took its origin.†

From the beginning the work was in charge of Captain Humphreys. He began field operations in November, 1850, but was compelled by severe illness, occasioned by exposure and overwork in surveying, to suspend them in the summer of 1851. He long remained an invalid, and upon his recovery was overwhelmed with other professional duties—among which may be named the general charge of all the Pacific Railroad surveys—so that the river work was not resumed until 1857. From that time, at his own request, he had the assistance of Lieutenant H. L. Abbot, to whom, with rare and characteristic liberality, he attributed an equal share in the authorship of the work. In his letter to the Bureau, Captain Humphreys, in speaking of the work, says: "It involved an amount of labor and study which will not, perhaps, be fully appreciated even by professional persons."

A scheme of field observations was devised covering a multitude and variety of observations in a vast region of more than one and a quarter millions of square miles, including the basins of the eight principal tributaries of the river, draining the entire surface between the Rocky mountains and the Alleghenies—the Missouri, Ohio, Upper Mississippi, Arkansas, Red, White, Yazoo, and St. Francis. The work was distributed among topographical, hydrographical and hydrometrical parties. An

* History of the American Civil War, by John William Draper, M.D., LL.D. Vol. 1, pp. 62.

‡ In the preparation of this account I have been assisted in my study of the original work by an able and exhaustive review of the Report of Humphreys and Abbot, by Edwin Hale Abbot, A.M., reprinted from the North American Review, April, 1862.

enormous mass of facts and data was collected and tabulated, showing the length, slope, dimensions of cross-sections, discharge, area of basin, downfall of rain, and drainage of the Mississippi and its tributaries. In this way all of the important facts connected with the various physical conditions of the river were ascertained, reduced and digested; the laws uniting them were determined, and out of seeming chaos the beautiful results of science were evolved, leading to simple and practical conclusions, and the great problem of protection against inundation was solved. Various suggestions, theories, and expedients, which had been much discussed in Europe, and broached in this country by Charles Ellet, were disproved and condemned. In the language of the Report: "It has been *demonstrated* that no advantage can be derived either from diverting tributaries or constructing reservoirs, and that the plans of cut-offs and of new or enlarged outlets to the Gulf, are too costly and too dangerous to be attempted."

The decision was in favor of the system of levees.

The question of the protection of the valley from inundation having been satisfactorily determined, attention was next directed to the improvement of navigation by the deepening of the mouths of the river. The first problem was one of national, the second of international, importance. In the same thorough way the facts relating to the delta were collected and studied, as well as those relating to the mouths of the river and their bars, and a plan was reported for increasing the depth of water on the bars. A ship canal was urged to obviate the difficulties and dangers of the passes, while the temporary and fallacious expedient of jetties was strongly condemned.

The spirit in which the entire work was executed is that of the well-chosen motto of the title page—the words of Franklin to Abbé Souliave—"I approve much more your method of philosophizing, which proceeds upon actual observations, makes a collection of facts, and concludes no further than those facts will warrant."

In addition to the purely scientific features of the work, it contains chapters of the utmost historic value. In chapter iii, the state of the science of hydraulics, as applied to rivers, is exhaustively considered. A complete chronological list is given of all the works bearing upon it, with a résumé of their contents. It sets forth all that was previously known about river hydraulics, both in Europe and in this country; with special studies, in part conducted by General Humphreys when in Europe, of the Nile, Neva, Rhine, Rhone, Garonne and the Po. The phenomena of great floods from 1718 to 1859 are fully stated, and a succinct account is given of the progress of the levee system in the Mississippi valley.

Finally, in elaborate appendices, each one of which is systematic and complete, the statistics are given upon which all computations are based. It is needless to state that the mathematical features, together with the maps and diagrams, are as elaborate as the other portions of the work.

A political lesson of the utmost consequence in its relations to the Fed-

eral Government is embodied in this report. The National Government accomplished in twelve years the solution, both in principle and in detail, of two great problems of internal improvement—protection from overflow and the deepening of the water on the bars—problems which had baffled all the efforts of four separate States for a century and a half. It is clear that the power which rules at the source of the great river must hold the channel, the delta and the mouths. Thus the Mississippi becomes at once the promise, the pledge and the bond of Union. "Whoever is master of the Mississippi is lord of the continent." The security of our national integrity must then be found, not only in constitutional provisions, congressional enactments, and in the coercive measures of war, but also in identity of commercial and industrial interests, supported by the vast possibilities of their indefinite development.

To return to our text.

An able reviewer says: "It is not too much to say, after a careful study of this report, that, as a work of science, it will not suffer by comparison with any in our language, while it is, in its special department, without a peer, and almost without a rival. It finds the whole subject of river hydraulics a confused congeries of discordant theories and untenable hypotheses, the offspring of insufficient generalizations. It leaves it a determined science, the result of wide observation of facts, acute and laborious combination and rigid and logical scientific analysis. Its authors may well be proud of their work, for it places them in the front rank of scientific men, and shows them to be the discoverers of a science, the first fruits merely of which appear in their deductions of the laws which regulate the flowage of the Mississippi."*

The work has been translated twice into German, twice into French, once if not twice into Italian, and once into Hungarian.

In 1865–'66, Humphreys published a voluminous report, entitled Examination of the Mississippi Levees. In 1875, General Humphreys, then the Chief of Engineers, published *Memoranda relating to the Improvement of the Entrance to the Mississippi River by Jetties*,† in which he enforced his views in favor of a ship canal. Elaborate diagrams were annexed. In 1878, Humphreys and Abbot published a reply to criticisms upon their work by Dr. Hagen, Director-General of Public Works in Prussia.‡ The tone of foreign criticism, with this exception, had been uniformly favorable and courteous.

We now pass from the consideration of Gen. Humphreys' labors as a man of science to view him as a soldier in the field. In this respect his skill as an engineer was of the utmost value. He had a quick eye for

* North American Review *ut supra*.

† Being Appendix S, 12, of the Annual Report of the Chief of Engineers for 1875. Washington, 1875.

‡ Physics and Hydraulics of the Mississippi. Reply to certain criticisms made by Dr. Hagen, Director-General of Public Works, Prussia. Von Nostrand's Eclectic Engineering Magazine, No. cix, January, 1878, Vol. xviii.

topography, and foresaw with remarkable accuracy how far the peculiarities of the region through which he campaigned would be available for the purposes of marching, assault, or defence. Col. Paine, "the pathfinder of the army of the Potomac," has said: "For general as well as intimate acquaintance with the country in which he was operating, and the troops against whom he was engaged—in fact, the general relative situation of affairs—Humphreys was second to no other Union General."

In 1861, Humphreys was a Major of Topographical Engineers. He was placed upon the staff of Gen. McClellan, with the rank of Brigadier-General of Volunteers, and became the Chief Topographical Engineer of the Army of the Potomac. When the advance upon Richmond was under consideration, though it is not recorded that he advocated a direct advance, yet it is known that he favored the "Urbana route," in preference to the movement up the Peninsula. He was engaged at the siege of Yorktown, in the battle of Williamsburgh, and in the movements and operations before Richmond and to the James river in 1862. His services at Malvern Hill were most conspicuous. He closed the lines, or, in other words, posted all the corps except the Fifth, and one division of the Fourth. The dispositions which he made contributed to the successful results of that eventful day, while the neglect to shell a wood, as he desired, allowed its occupation by the enemy, from which they had to be driven by force.

On the return north of the Army of the Potomac, he was transferred from staff or engineering duty, to the command of a division of new troops, with which he pressed to Antietam, "marching with commendable activity," a march of more than twenty-three miles on a dark night to take part in the expected battle of the next day. After that battle he made a reconnoissance in the Shenadoah valley, which has been spoken of as "one of the finest and most thorough possible to be made, indicating the possession of every quality necessary to a thorough soldier."

At the battle of Fredericksburg, 13th of December, 1862, he personally led a charge, which for desperate valor has few equals in the annals of war.

When Sumner was directed to storm the heights above the town, he selected the divisions of French and Hancock for the assault.

The position to be carried had by nature strong defensive advantages. Between the canal—which had to be crossed—and the crown of the ridge of hills the space was covered by fences and buildings, while at the foot of the ascent proper to Marye's Heights a sunken road, running behind a high stone wall, afforded as perfect a defensive work as if planned and constructed by engineers. This line of defense was still further strengthened by fortifications in the rear, which rose tier upon tier, so that the Confederate infantry was enabled to deliver a concentric fire. Indeed the head of the assaulting column "seemed to propel itself into a yawning gulf of flame."

The first attack was made by French, with the Third Division of the Second Corps, with a boldness and steadiness that carried him to within

thirty or forty paces of the wall. He was badly repulsed, and withdrew, leaving twelve hundred dead and wounded out of about twice that number. The second attack was made by Hancock with the First Division of the Second Corps. His line broke within twenty-five paces of the wall. In the short space of a quarter of an hour two thousand and thirteen lifeless or mangled forms were added to the victims of the former attempt.

Humphreys was next sent over. Gen. Palfrey says: "Some of the very best fighting that was done at Fredericksburg was done by the Third Division of the Fifth Corps. The division was commanded by Gen. Humphreys, who was probably the best officer in the Army of the Potomac that day. He was a thoroughly educated soldier, possessed of a quick eye and a clear head, and a man of fiery energy. That the fighting his divison did was so good was due to him."*

He had but two brigades, one commanded by Col. Allabach, the other by Brigadier-General E. B. Tyler. Several of his regiments had never before been in battle. His men divested themselves of their knapsacks, haversacks and overcoats, and then moved across the canal. Humphreys in person formed the leading brigade in a ravine about three or four hundred yards from the stone wall, and then led the advance in line of battle, but found to his surprise that Couch's men were lying down behind a small fold in the ground about one hundred and fifty yards or less from the wall. He then ordered a bayonet charge, but failed to carry the wall, owing to the disorder into which his men were thrown by those who were lying on the ground several ranks deep. Upon turning back to his second brigade, he discovered that artillery had been placed by Hooker on the very ground his troops must pass over.† Quickly riding to every gun he put a stop to the firing, and led forward his second brigade, directing it to run over the men in front. Notwithstanding the confusion incident to the effort to obey this order, the onward impetus of the line carried it close to the wall, when a sheet of flame ran along its entire length, accompanied by a long roll of thunder, and wrapped the column in an embrace of fire. Twilight was fast deepening, and amid the thick mists of the bottom land every discharge was as brilliant as the trail of a rocket, thus adding to the grandeur and terrors of the scene.

Two horses were shot under the intrepid leader, who hastily mounted a third, and continued to ride about amid the rain of missiles, bearing a charmed life; his clothing was pierced and rent, but his person was unhurt. Every officer of his staff but one, his son, was dismounted, and his horse was badly wounded. In vain did Humphreys endeavor to halt his men as they turned slowly backward. In vain did he endeavor to remedy the disorder occasioned by the troops lying down whom he had been sent

* Antietam and Fredericksburg, by Gen. Palfrey. Scribner's Campaigns of the Civil War.

† Note to p. 252 of Campaigns of the Army of the Potomac, by Wm. Swinton. Appendix, Revision and Re-issue. Scribner, 1882. Humphreys' Charge on Marye Heights.

to support; in vain did he endeavor to induce them to rise and join in the charge, and with some bitterness he subsequently wrote that had they been withdrawn before he moved forward, a different result would have followed. Indeed, so near was he to carrying the wall and heights that the enemy were actually moving their guns out of the batteries, and on the right they were beginning to quit the wall.*

"His division, like the third breaker upon a beach, left its traces of blood and wrecks a few paces further on, and nearer to the enemy than the preceding two, lingered longer, strove harder to maintain itself so far, and to accomplish the impossible. Finally it withdrew, singing in chorus, to show that although shattered physically, morally its spirits were unshaken. His charge will yet be blazoned forth in history as one of the noblest efforts of Northern resolution, or, as he expressed it, of one of Kearney's exhibitions of valor "magnificent." †

The reckless bravery of Humphreys as displayed on this and other occasions, proved that he had a keen relish for conflict. Not that he delighted in slaughter, or had the slightest trace of ferocity in his nature, but the romantic love of peril and adventure, the wild rapture of battle (*certaminis gaudia*), the thrilling occasion, the mighty shock of armed men, the encounter of mind with mind, of strategy matched against strategy, of force directed against force, the issues trembling in the balance, and the possible grand result, aroused all the tremendous energies of his intellect, and transformed the quiet scholar into the very embodiment of resistless heroism. Like the war horse, in Job, he mocked at fear and was not affrighted; neither turned he back from the sword. "Of all the sublime sights within the view and comprehension of man," he wrote, "the grandest, the most sublime, is a great battle. Its sights and sounds arouse a feeling of exaltation, compared to which, tame indeed is the sense of the sublime excited by all other great works, either of God or man." And again: "That which makes the thrilling interest of a battle is the personal incident. A battle so lifts a man out of himself that he scarcely recognizes his identity when peace returns, and with it the quiet occupations."

He was breveted Colonel United States Army, for gallant and meritorious services, with a commission bearing the date of the battle of Fredericksburg, and was warmly pressed by Burnside for a full Major-General's commission. His promotion, however, was of later date.

His next services in the field were at Chancellorsville, where he commanded the Third Division of the Fifth Corps, then commanded by Meade. He was posted upon the extreme left, where, near the brick house called the Chancellor house, he was sharply engaged with the enemy. In his testimony before the Joint Committee of Congress on the conduct of the war, he declared that he probably knew less in regard to the battle of Chancellorsville than any other battle he ever took part in. With other

* Letter of Gen. Humphreys to Wm. Swinton, May 10, 1866, *ut supra*.

† De Peyster.

distinguished officers he strongly disapproved of the order by which the army was withdrawn from its advanced position and compelled to fight a defensive instead of an offensive battle.* Many years after, in commenting on this battle, Gen. Humphreys said: "The Army of the Potomac did not fight at Chancellorsville. The Eleventh Corps, badly posted, was permitted to be surprised by overwhelming numbers, and routed. The Third Corps, aided by artillery, posted by Pleasonton, threw itself into the breach, arrested the forward movement of the enemy, and the next morning was allowed to sustain the attack of Lee's whole force for several hours, losing in killed and wounded a large part of its numbers. It was of course obliged to fall back upon the other portion of the army, the First, Second, Fifth and Twelfth Corps, in position near by, just in rear of Chancellorsville. Only parts of some of these corps were partially engaged in covering the withdrawal of the Third Corps. Sedgwick advancing from Fredericksburg, with the Sixth Corps and one Division of the Second Corps, was attacked by Lee, and forced back over the Rappahannock. Lee, in this operation, had 60,000 men, Longstreet's Corps being absent; Hooker not less than 90,000 men. It is not surprising, then, that the Army of Northern Virginia should have made a false estimate of its prowess, or at least of that of the Army of the Potomac."†

Shortly after the battle of Chancellorsville, Gen. Meade, in a private letter, dated May 19, 1863, wrote as follows: "I have lost nearly a division by the expiration of service of the two years and nine months men, so that I have had to break up Humphreys' Division, and he is going to take command of the division recently commanded by Gen. Berry in Sicklés' Corps. I am very sorry to lose Humphreys. He is a most valuable officer, besides being an associate of the most agreeable kind."

The intimate relations between the two friends was, however, soon to be reëstablished. A gentleman, whose knowledge is undoubted, writes: "The fact stands that when Gen. Meade was placed in command of the Army of the Potomac, the first man he thought of, and whom he called to his assistance was Gen. Humphreys. The reason why he was not his Chief of Staff at Gettysburg was solely due to Humphreys' own desire to command his division in the coming engagement. He thought that at that particular crisis he could render greater assistance in the position he then held. In addition to this he always had a great partiality for commanding troops, especially in a fight."‡

At Gettysburg, where Humphreys commanded the Second Division of the Third Corps—a division which had always been a favorite—he displayed not only coolness and valor, but consummate skill in handling

*Report on the Conduct of the War. 1865, Vol. I, pp. 61-65.

† Address of Maj. Gen. A. A. Humphreys on the Military Services of the late Maj. Gen. George Gordon Meade, at the Meade Memorial Meeting of the citizens of Philadelphia, Nov. 18, 1872. Washington, D. C., 1872.

‡ Letter of Col. George Meade to the writer. Testimony of Gen. Humphreys before the Committee on the Conduct of War. Report on the Conduct of the War, 1865, Vol. I, p. 388.

his troops. As he pressed forward to the town of Gettysburg on the evening of the first of July, he was informed that the enemy had made their appearance there in force; that the First and Eleventh Corps had been very hotly engaged, and that Gen. Reynolds had been killed. He was directed to follow a road about two miles west of the main one, and learned that Lieutenant Colonel Hayden, Assistant Inspector-General of the Corps, was present with a gentleman from Gettysburg, who acted as a guide for the route that Gen. Sickles wished him to take. Contrary to Gen. Humphreys' views who wished to move to the right so as to join Howard's left, Col. Hayden insisted that Gen. Sickles wished him to approach by the Black Horse Tavern road, which led towards the left directly to the enemy. With many misgivings Humphreys obeyed. His movement occupied considerable time owing to the crossings of Marsh run. He took the precaution of directing his column to move quietly as it approached the road, and to close up, as he expected to fall in with the enemy. He soon found the enemy posted in force, but unaware of his presence. He might have attacked them at daylight with the certainty of at least temporary success, but as he was three miles distant from the remainder of the army, he believed that such a course would be inconsistent with the general plan of operations of the commanding General. As soon as he ascertained the exact condition of things, he retraced his steps and bivouacked near Gettysburg about 1 A. M., on the 2d of July. This delayed him several hours, and greatly fatigued his men. It was a moonlight night, but hazy. The reference, which Gen. Humphreys makes to what others have admired as an exhibition of remarkable skill in extricating his division from a dangerous position, is one of characteristic modesty. He says: "It shows what can be done by accident. If any one had been directed to take a division to the rear of the enemy's army and get up as close as I did unperceived, it would have been thought exceedingly difficult, if not impossible to do it unnoticed."*

It was subsequently ascertained that Col. Hayden had entirely misapprehended Gen. Sickles' order, and that it had never been intended that the division should march by way of the Black Horse Tavern.

The next morning, the 2d, his division, forming the right of the Third Corps, was massed on a ridge of elevated ground between Cemetery Hill and Round Top, some four or five hundred yards in advance of the general line. This placed the entire corps in great danger. In the afternoon he was fiercely attacked in front and flank, and sustained some of the hottest fighting of the day. While under a heavy fire of infantry and artillery—"I have never been under a hotter artillery and musketry fire combined," he states—just at the moment he found it necessary to get his own artillery out of the way as quickly as possible, and advance his whole line to pour a fire upon the charging enemy, he received an order from Gen. Birney informing him that Gen. Sickles had been wounded, and that he

*Testimony of Gen. Humphreys. Report on the Conduct of the War. 1865. Vol. 1, p. 389. *Ut supra*, p. 390.

had succeeded to the command of the Corps, and that his division was going to fall back and form in line extending towards Humphreys' right from the Round Top ridge in rear of and oblique to his present line, and that he must change front and form on that line. In complying with this order, he had to change from front to rear. While making the movement, the troops on his left failed to stop on the Round Top ridge, but passed beyond it. Humphreys instantly extended his line to the left to close up the aperture, and was attacked on his flanks as well as on his front. For a moment he thought the day was lost. Just then he received an order to fall back to the Ridge, which he did slowly and in good order, stubbornly contesting every inch of ground, and suffering a very heavy loss. "I did not fall back rapidly," he says, "because I disliked to fall back at double quick before the enemy, and besides I did not suppose I could rally my troops, or that any troops could be rallied at the place where the line was to be formed, if the movement backward was made rapidly." He reached the ridge, leaving three guns behind, the horses of which had been killed, and rallied the remnants of his division. Quickly wheeling, as the enemy came up, he poured in a fire, and his troops, joining in with the Second Corps, drove back the foe, recovering the lost guns. His men did not wait for orders, but dashed impetuously forward, and as there were so few of them, he went with them to bring them back before they got too far from the main line. By that time it was dusk, and the fighting ceased for the day.*

On the third day, while moving into position, he was fiercely shelled by the enemy, and about four o'clock in the afternoon formed his division into columns of attack, and prepared to advance. While in this position he lost some valuable officers, as well as men. No orders were given to advance, and as the enemy did not renew their attack, which was the great feature of the day, he returned to his position on the left, where he remained until the army moved from Gettysburg.

The services of Humphreys in this battle added greatly to his renown. His skillful handling of his troops and his desperate conflict and coolness in the peach orchard, where his son was wounded at his side, added new laurels to his chaplet, and resulted, on the 13th March, 1865, in a brevet as Brigadier-General United States Army.

Four days after the battle of Gettysburg he accepted the position tendered him by Gen. Meade, as Chief of Staff of the Army of the Potomac, which he held from 8th July, 1863, to 25th November, 1864. He bade farewell to his command in these well-weighed words of commendation: "In parting from this celebrated division, after having commanded it for the brief period of fifty days, I trust that I may be excused for expressing my admiration for its high soldierly qualities. It is impossible to pass it in review even without perceiving that its ranks are filled with men that are soldiers in the best meaning of this term, and that it possesses in the

* *Ut supra*, p. 392. Swinton's Army of the Potomac. Gettysburg, the second day, pp. 342–355.

grade of commissioned officers, men whose skill, courage and accomplishments would grace any service."

As Chief of Staff he was engaged in the action of Manassas Gap; the Rapidan operations; the action on the Rappahannock and the combat of Bristoe Station; the operations of Mine Run, the battles of the Wilderness, Spottsylvania, North Anna, Tolopotomy, Cold Harbor, Petersburgh, the Weldon Railroad, Peebles' Farm and the Boydton Plank Road.*

During the fall and winter of 1863–'64, he thrice planned the surprise and destruction of Lee, but his plans were frustrated partially by disobedience of orders and partially by modifications to which he did not assent, and the attempts were barren of results. As he has modestly refrained from specific statements in his little book, "Gettysburg to the Rapidan," the facts can be gathered only from sources not yet public. He served his chief with absolute fidelity and staunch friendship, but his services, though of great importance, could not be fully appreciated by the public. A competent military critic has remarked that "what Von Moltke was to the King of Prussia, afterwards Emperor of Germany, what Blumenthal was to the Crown Prince, Humphreys was to Meade in many respects."

On the 26th November, 1864, he resigned his position as Chief of Staff, to succeed Hancock in the command of the Second Corps, or, properly speaking, the combined Second and Third Corps, a fusion of which he did not approve as destructive of the *corps de esprit* of both.†

In a private letter of General Meade, dated November 25, 1864, he says: "Hancock leaves us to-morrow, he having a leave of absence, after which he will be assigned to recruiting duty. Humphreys takes his place. The change in my position has rendered it unnecessary to have an officer of Humphreys' rank as Chief of Staff. I deemed it due to him to suggest his name as Hancock's successor."

On assuming his new command, he said: "It is natural that I should feel some diffidence in succeeding to the command of so distinguished a soldier as Major-General Hancock. I can only promise you that I shall try to do my duty and preserve your reputation unsullied, relying upon you to sustain me by that skill and courage which you have so conspicuously displayed on so many fields."

From that time forth, his career is marked by a series of brilliant successes. He now had a fair opportunity to display his capabilities as a general.

The winter of 1864–'65 had been severe and the Confederate army suffered much from want of food. Their supplies were brought by wagons from Hicksford on the Weldon Railroad, forty miles south of Petersburgh. To break up this route of supply, Humphreys was ordered to coöperate with the Fifth Corps, which, in turn, was to support Gregg's cavalry of the Army of the Potomac. On the 6th of February, Humphreys began his operations by throwing a bridge across Hatcher's run. On the 6th, a se-

* Statement of services, *ut supra*.

† "Bird's-Eye View of the War," by Col. Dodge.

vere action took place, which resulted in the extension of the Federal entrenchments to the left as far as Hatcher's run at the Vaughn Road crossing. Humphreys was on the extreme left, with the Fifth Corps massed in support. On March 25th, Lee made his desperate attack upon Fort Stedman, a blow aimed at the Union base of supplies at City Point, which, though well conceived and gallantly executed, was frustrated by the good conduct of Gen. Hartranft. On the same day Humphreys and Wright, availing themselves of the opportunity thus offered, attacked Lee upon their respective fronts, and accomplished most valuable results, which contributed to the success of Wright's assault on the morning of the 2d of April, by which the enemy's entrenchments were carried, and Lee forced to abandon his lines. On the 30th, Sheridan had his fight at Dinwiddie Court House, and on this day when Warren met with temporary disaster, while advancing to cut Lee's communication with his extreme right, Humphreys suddenly launched his first division under Miles against the successful Confederates, striking their front and flank, "withering their triumph," driving them back, capturing three hundred prisoners, and advanced to the White Oak road, the first time that this important thoroughfare had been reached by our troops. On the 1st and 2d of April, the Second Corps carried the works in their front, and Miles again won laurels at Sutherland Station.

On the evening of April 2d, Lee began his retreat. Early on the morning of the 3d, Petersburgh was occupied by General Willcox, and at 8 A. M. Richmond fell, and the great pursuit began ; the cavalry, under Sheridan, supported by the Fifth Corps under Warren, leading the advance, while the Second Corps followed, rapidly building bridges and repairing roads. Sheridan, with Crook's Division and the Fifth Corps, arrived, at about 4 P. M., at Jetersville, and entrenched there, so as to dispute Lee's attempt to join Johnston. On the morning of the 4th, Lee was at Amelia Court House, but instead of attempting to break his way through Sheridan's lines, dallied there to bring up his baggage. The delay was fatal. On the 5th, the Second Corps reached Jetersville, followed by the Sixth. In the evening, Lee finding the forces in his front too strong to be attacked, turned north, and pushed towards Farmville in search of supplies. Early on the 6th, the Army of the Potomac moved out, "like the ribs of a fan," from Jetersville, in the direction of Amelia Court House, where they expected to meet the Army of Northern Virginia in battle array. But, instead of awaiting them there, Lee had nearly slipped by their front westward. While Sheridan and his immortal cavalry, supported by the Fifth Corps, were dealing with the advance bodies of Lee's army, Humphreys was fighting and driving the compact and well-organized forces that remained, hanging persistently upon their flank and inflicting wounds from which, as has been said, "Lee bled to death." The conspicuous service rendered by Humphreys was in retarding and crippling the retreat of the main body, thus rendering it possible for the cavalry to head off the advance. On the 6th, at 8 A. M., Humphreys caught up with the

enemy at Flat creek, his men partly fording the stream, armpit deep, and partly crossing it upon a hastily improvised bridge, and after having been engaged in seven stand-up fights over a distance of fourteen miles, and carried several partially entrenched positions defended by artillery, closed the day with a sharp action at nightfall with Gordon's division at Perkinson's Mill, near the mouth of Sailor's creek. In the meanwhile Ewell's division, "split off by Humphreys," fell into the hands of the cavalry at Little Sailor's creek, and surrendered about six thousand men.*

During the night, the enemy again slipped away, but in the morning, shortly after daylight, Humphreys swept down upon High Bridge, and secured the only viaduct across the Appomatox which the Confederates had not burned or succeeded in destroying in their hurried flight. Four miles further on, at the Heights of Farmville, or Cumberland Church, Humphreys again fell upon a solid body of the enemy, and as the roar of his guns burst upon the ear, Lee is reported to have said, "There is that Second Corps again." Here Humphreys held him until night, having sent word to General Meade that Lee's whole remaining force, about 18,000 infantry, had been overtaken, and suggesting that a corps should attack Lee from the direction of Farmville, four miles off, at the same time that the Second Corps attacked from the opposite direction. The river near Farmville proved impassable, and Humphreys was obliged to contend with the enemy without support. The enemy's position was naturally strong and well entrenched, and though Humphreys failed to carry it, he clung so persistently to his purpose as to succeed in detaining Lee there until night, a loss of invaluable time which he could not regain by night marching. He therefore lost the supplies awaiting him at Appomatox station, and Sheridan with his cavalry, and Ord with the Fifth and Twenty-fourth Corps were enabled to post themselves across his path at Appomatox Court House, about fifty miles further on.

Had Humphreys failed to secure High Bridge, had no infantry crossed the Appomatox on the 7th, Lee would, in all probability, have effected his escape. He could have reached New Store that night, Appomatox station on the afternoon of the 8th, obtained the rations there, and moved that evening towards Lynchburg. A march next day, would have brought him

*I am under obligations to Brevet Major-General (S. N. Y.) J. Watts De Peyster for assistance in the preparation of this account. In addition to the examination of several papers written by himself, which he kindly placed in my hands, I have studied the maps in his elaborate work, La Royale, The Grand Hunt of the Army of the Potomac, which was printed for private circulation, the value of which is acknowledged by General Humphreys in the preface to "The Virginia Campaign of '64-'65."

The remaining authorities are: "With General Sheridan in Lee's Last Campaign;" "The Virginia Campaign of '64-'65;" "Scribner's Campaigns of the Civil War;" The Histories of the Civil War, by Draper, Lossing, and Harper's General History; Swinton's "History of the Army of the Potomac;" with a number of special papers, addresses and reports. I must also acknowledge the assistance of Major Jos. G. Rosengarten and Col. Jno. P. Nicholson.

to Lynchburg, where he would have been safe.* The value of Humphreys' services in crossing the Appomatox and detaining Lee all day at the Heights of Farmville or Cumberland Church will be appreciated, when it is remembered that Ord's two infantry corps did not reach Appomatox Court House until 10 o'clock in the morning of the 9th of April, and that it was the sight of Ord's infantry supporting Sheridan, that convinced Gordon that further fighting was useless and escape impossible.

About half-past eight o'clock on the evening of the 7th, when still in close contact with Lee, as has been described, Adjutant-General Seth Williams brought to General Humphreys Grant's first letter to Lee asking the surrender of Lee's army. This letter Humphreys was requested to have delivered to General Lee. He sent it at once through his picket line, at the same time authorizing a truce for an hour, to enable the enemy to gather up their wounded. At this time the opposing troops were but a few hundred yards apart. Lee's answer was brought back within an hour, and General Williams started at once to return to General Grant at Farmville by the circuitous route of High Bridge. The next morning Humphreys resumed the pursuit. While on the march, Grant's second letter to Lee was brought to Humphreys, who sent it to Lee through Fitz-Lee's cavalry rear guard which was then close in Humphreys' front. Lee's answer was received by Humphreys about dusk, as he halted for a three hours' rest, two miles beyond New Store, after a march of twenty miles. He again pushed forward, but after a march of twenty-six miles, was compelled to halt his column at midnight, on finding his men dropping out of the ranks from want of food and fatigue. On the morning of the 9th Humphreys received Grant's third letter to Lee, which was delivered to him in person by Colonel Whittier, of Humphreys' staff. Lee's answer was delivered by the hands of Colonel Whittier to General Meade, who forwarded it to General Grant, who had then left the route followed by the Second and Sixth Corps, and taken a cross-road which led to Appomatox Court House, and along or near the routes of Sheridan and Ord. Had Grant remained on the route of the Second and Sixth Corps, the surrender would have taken place before midday. As it was, Grant having ridden forward, the meeting between himself and Lee did not take place until one o'clock P. M., and the surrender of the Army of Northern Virginia was not announced to the Army of the Potomac until four o'clock. The remainder of this celebrated correspondence passed through the lines of General Sheridan.†

In the meantime General Humphreys, closely followed by the Sixth Corps, pressed forward, and began to overtake Longstreet, when he received two earnest verbal requests from General Lee, by a staff officer, with a flag of truce, not to press forward upon him, but to halt, as negociations were going on for a surrender. As Humphreys had been notified

* The Virginia Campaign of '64-'65, p. 391; Scribner's Campaigns of the Civil War, Vol. xii.

† The Virginia Campaign of '64-'65, p. 394.

that the correspondence was in no way to interfere with his operations, he twice sent word to Lee's staff officer that the request could not be complied with, and that he must withdraw from the ground at once. At this time, he was in full sight on the road, not a hundred yards distant from the head of the Second Corps. Humphreys at once formed his corps for attack, the Sixth Corps formed on the right, which, at the moment it was about to begin, was suspended by the arrival of General Meade, who granted a truce for an hour. Hostilities were never resumed. The Great Civil War was at an end.

These facts are sufficient to illustrate the relentless character of Humphreys' pursuit, and attest his ability as a corps commander in handling men worn out by hunger, fatigue, long marches and severe fighting. They fitly close his active military services in the field.

In the grand review of the Army of the Potomac, at Washington, the Second Corps participated, and one of the noticeable features of the occasion was the appearance of General Humphreys' staff mounted upon white horses, a delicate compliment to the noble grey who had carried him so gallantly through the fatigues of the march and the perils of battle. The old war-horse still lives, with but slight abatement of her wonted spirit.

General Humphreys was in command of the District of Pennsylvania, in the Middle Department, from July 28 to December 9th, 1865.

From December, 1865, to August of the following year, he was in charge of the examination of the Mississippi levees, a work rendered necessary by the neglect and damage of the war.

On August 8, 1866, he was appointed to the command of the Corps of Engineers, with the rank of Brigadier-General and Chief of Engineers, serving in this capacity until his retirement from active service, at his own request, on June 30, 1879. He thoroughly organized this branch of the service. The work of the general office was divided into four divisions, and an officer of special fitness placed in charge of each, while officers of rank and experience were assigned to important districts and duties.

He served as a Member of the Lighthouse Board, from 1870 to 1874; of the Commission to examine into canal routes across the Isthmus connecting North and South America, from 1872 to 1877; of the Board on Washington and Georgetown Harbor improvements from 1872 to 1873; of the Revising Board of Bulkhead and Pier Line of Brooklyn from May, 1872, to June, 1879, of Staten Island from August, 1878, to June, 1879, and of Hudson river (Troy to Hudson), June, 1877, to June, 1879; of Board for Survey of Baltimore Harbor and adjacent waters from May, 1876, to June, 1879; of the Washington Monument Commission from January, 1877, to June, 1879; of the Advisory Board to Massachusetts Harbor Commissioners from January, 1877, to June, 1879, and of the Examining Board of Moline Water Power Company contracts during 1877.*

In the civil duties appertaining to his profession he was as eminent as in

* Statement of Services, *ut supra.*

his military duties in the field. In 1857 he was chosen a member of the American Philosophical Society held at Philadelphia, Pa., of which both his grandfather and father had been members, and of the American Academy of Arts and Sciences of Boston, Mass., in 1863 ; a corporator of the National Academy of Science in 1863 ; an Honorary Member of the Imperial Royal Geological Institute of Vienna in 1862, of the Royal Institute of Science and Art of Lombardy, Milan, Italy, in 1864 ; and corresponding member of the Geographical Society of Paris, and of the Austrian Society of Engineer Architects, and an Honorary Member of the Italian Geological Society in 1880. The Degree of LL.D. was conferred upon him by Harvard College, July 15, 1868.

After retirement from the Bureau, the last intellectual labor performed by General Humphreys was in the composition of two books, which together constitute a military classic and a mine of important matter relating to the history of the war—"The Virginia Campaign of '64–'65," and "From Gettysburg to the Rapidan"—the latter being, properly, an introduction to the first.

The amount of work bestowed upon them was immense, and the results exhibit extraordinary power of intellectual compression. Indeed for many they will prove too concise and dry to be interesting, but no one can be at a loss to understand the operations described. With entire freedom from ostentation or rhetorical parade he closes the former book in these words: "It has not seemed to me necessary to attempt an eulogy upon the Army of the Potomac or the Army of Northern Virginia." These were his merits as a writer—precision, brevity, simplicity—a style suited to his subjects, but not one to attract the general reader.

One of the most gratifying personal tributes to General Humphreys was the presentation of a memorial sword by the citizens of Philadelphia, on the evening of the 4th of July 1866,* at the building of the Union

* THE SWORD presented to Major-General A. A. Humphreys, U. S. Army, by his fellow-citizens of Philadelphia, 1866. *E Pluribus Unum.* Liberty and Union This on one side; on the other side:

Yorktown, April 15th, to May 4th, 1862.
Williamsburg, May 6th, 1862
Chickahominy, May and June, 1862.
Malvern Hill, July 1st, 1862.
Fredericksburg, December 13th, 1862.
Chancellorsville, May 1863
Gettysburg, July 1st, 2d, 3d, 1863.
Manassas Gap, July 1863.
Rappahannock, October to November 7th, 1863.
Mine Run, November 29th to December 3d, 1863.
Rapidan, February 1864,
The Wilderness, May 6th and 7th, 1864.
Spottsylvania Court House, May 9th to 20th, 1864.
The South Anna, May 21st to 25th, 1864.
Totopotomy, May 28th, 29th, 30th, 1864.
Cold Harbor, June 1st, 2d, 3d, 1864.
Petersburgh, June 16th, 17th, 18th, 1864.
The Mine, July 30th, 1864.
The Weldon Railroad, August 18th, 25th, 1864.
The Boydtown Road, October 27th, 28th. 1864.
Hatcher's Run, February 4th, 5th, 6th, 1865.
The Fall of Petersburgh, March 25th to April 3d, 1865.
Pursuit of Lee.
Sailor's Creek, April 6th, 1865.
The Heights of Farmville, April 7th, 1865.
The Surrender of Lee, April 9th, 1865.

League. From his boyhood, he had been almost a stranger to his native city, and was personally unknown to many of her leading citizens, but his distinguished scientific and military services had become a part of the imperishable history of the nation, and entitled him to this tribute of respect, affection and gratitude. The lofty conception which he entertained of his noble profession, inspired the words with which he received the gift: "The sword is regarded as the emblem of manly virtue, of a just mind, a courageous heart, and a gentle spirit. No token of your regard for me as a soldier and as a man could be more acceptable, and, perhaps, I most fittingly acknowledge your gift in saying that I shall try so to wear this beautiful embodiment of all the qualities a sword should possess, that its spotless blade may never be stained, nor its brilliant lustre dimmed."

This was his ideal of the model soldier. It is not too much to say that in thought, word and deed he fulfilled and illustrated it.

At the Meade memorial meeting of the citizens of Philadelphia, held on the 18th November, 1872, Gen. Humphreys delivered an address upon the military services of General Meade. It is an able and luminous review of complicated operations, and without the aid of turgid adjectives or pretentious nouns, embodies the highest tribute ever paid by a military critic to a great commander. After a thorough discussion of the question why Meade did not capture Lee after the battle of Gettysburg, General Humphreys declares: "After a careful examination of the subject so far as I am capable of forming an opinion, I am led to the conclusion that Meade, at Gettysburg, had a more difficult task than Wellington at Waterloo, and performed it equally well, although he had no Blücher to turn the scale." From such a critic what praise could be higher, and yet what could be simpler in point of expression?

In drawing to a conclusion this imperfect review of the career of Gen. Humphreys, it will be proper to quote a few carefully selected expressions of opinion by men qualified by their public positions and professional attainments to form a competent judgment.

Gen. De Peyster says: "In the death of A. A. Humphreys, the United States lost without question their most thoroughly scientific engineer and soldier and general combined; illustrious in every branch of the service which he adorned; equally able as an engineer for the use of inert materials, and as a general for the handling of living masses, and as a soldier for setting an example of intrepidity, * * * * * in topography, geodesy and dynamics he was equally eminent, and his pen was not more capable of demonstrating the laws which govern natural cataclysms than his sword in cutting the Gordian knot of difficulties by his bold strategy and bolder tactics."

Gen. Hancock has declared "That if he were an absolute monarch, and could dispose of a large army; he knew of no one whom he would place at its head with such perfect confidence as Humphreys."

Another major-general of distinction has said: "Humphreys' leader-

ship and soldiership were so unobtrusive that the country was not aware of what an able man it possessed in him."

"General Humphreys," wrote a gallant soldier, afterwards occupying an important civil position, "holds a place in my estimation as a soldier whose skill, bravery, and modesty are second to none, and whose real service was infinitely more valuable than that of many officers more talked about in the newspapers."

Another writes: "If Humphreys had enjoyed a more influential position the Northern people would have enjoyed many more occasions to rejoice. This must have been the case if the power of handling large bodies of troops; if rare science and its test—application; if calmness and clearness of judgment under fire; if energy, undaunted courage and self-forgetfulness in view of results have any effect upon military operations."

Major Bundy styled him "a scientific soldier, a wise and safe counsellor."

A military critic as far back as in 1869, wrote: "As a fighting division commander, as a proficient in the handling of a corps; as a consummate chief of staff of the Army of the Potomac; as an intrepid gentleman; as a faithful soldier, and as a remarkable engineer, Gen. Humphreys had no superior. His survey and reports upon the Mississippi will be as proud a memorial of his engineering capacity as his military record, beginning with the Florida war, in 1836, is a record which is without a stain, as rich in historic deeds and services as the sacred shield of Lancelot."

An ardent admirer and devoted friend pays the following tribute: "A great and at the same time a good man, who attained the ripest age with undiminished faculties; a magnificent soldier who combined the calmest intrepidity with executive ability in battle, a mind capable of working with the nicest precision amid the wildest churme of conflict under exceptional circumstances of peril; a scientist of views most comprehensive and practical; of knowledge vast and developed."

These are the amaranths with which his companions in arms have crowned his name.

In private life, General Humphreys was courteous, kind, gentle and affectionate. His love and enjoyment of home were sincere and unaffected. He married, June 19, 1839, Rebecca, the youngest daughter of Henry Hollingsworth, one of the mostre spected citizens of Philadelphia, and had two sons and two daughters, of whom the former and one daughter survive. To him, wife, daughters, sisters, were not merely the objects of affection, but the embodiment of that perfect womanliness at whose shrine he knelt in reverenee. His mind idealized all that it dwelt upon and both absorbed and imparted radiance. He had a refined and cultivated taste for art and literature and in some respects was fastidious to an extreme degree.

His attachments to the home of his ancestors were strong and peculiar. No rage for modern improvement or convenience could ever induce him to change the structure or arrangement of the old and strange house he had inherited, jumbled together with the additions of several generations. Its lowly roof and straggling sheds embowered in vines were sacred. The

ivy that clambered about the windows, the venerable chestnut trees, the hirsute shrubbery, the old pump, surrounded by a hedge of lilacs, were the objects of his interested care. In the quiet burying-ground on the hill, I have seen the great soldier, whose fame had penetrated Europe, bend in respectful silence over the stone that marked the grave of some forgotten relative, or have listened, as he trod the well-loved fields of his childhood, to his recollections of those joyous days.

Such was the man. As simple in his greatness as he was great in his simplicity; of noble strength in body, heart, and brain, a union of opposites, a man who had devoted his whole life to the public good, and yet one of whom the public knew but little, partly because of his modesty, partly because his favorite studies were abstruse and recondite, but chiefly because he had none of the instincts of the politician, and scorned the artifices by which so many rise to popularity and fame.

He died on the 27th of December, A.D. 1883, in the seventy-fourth year of his age, while seated in his chair, without pain, and without a struggle.

"The best death," said the great Roman, "is that which is the least expected."

Fellow-members of the American Philosophical Society—In the bright galaxy of names which adorn our rolls there are stars of the first magnitude, whose glories have fixed the gaze of nations. Historians, statesmen, jurists, physicians, soldiers and philosophers—our great men have walked upon the high places of the earth. Their exertions have manifested the noblest intellectual power; their industry has tilled every field of activity; their studies have sounded every depth of knowledge; their daring zeal has penetrated to the remotest bounds of science; their devotion has made willing sacrifice of property and life; their success has won the highest meed of honor. Our Franklin, our Rittenhouse, our Bartram, our Wistar, our Kane, our Binney, our Sharswood, and he, whose recent death we all deplore, that grand old man, whose noble life was spent in acts of public usefulness and private benevolence which have endeared his name and consecrated his example—our Price—are they not all men of whose achievements we can boast without affectation, of whose deeds we can speak with pardonable pride?

Among these we now enroll the name of Humphreys. No chiseled marble preserves his lineaments, no lofty columns proclaim his worth, no demagogues attempt to conjure with his rod, but long after the fierce passions of our civil strife shall have burned themselves to ashes, long after his services to the cause of the Union and free government shall have risen to their proper place in military annals, when Oblivion shall have wrapped Secession in her mantle, and fraternal affection shall have buried the weapons of war, the memory of his scientific labors will live as his most enduring monument. He tamed the raging of the floods; he snatched from devastation the most fertile and magnificent valley in the world—the seat of future empire—and opened up the great Father of Waters to the commerce of the globe.

Let us add with pride—he was a Pennsylvanian and a Philadelphian.

Biographical Notice of Henry M. Phillips. By Richard Vaux.

(Read before the American Philosophical Society, Dec. 19, 1884.)

It rarely happens that a marked or lasting impression is made on the public mind by merely professional men. Devoted to the consideration of principles of paramount importance intrinsically and relatively, they are only applied in their direct operation within a limited circle. It is therefore those larger spheres, the arenas in which achievements are of signal importance, both to direct thought and excite actions that are not usually accessible to those trained in special studies, and who devote their powers to circumscribed mental efforts.

The legal training, while it is the best foundation for the highest successes in public life, and especially qualifies for a participation in the responsible duties of public affairs, if exclusively absorbed in professional duties fails to imprint itself on the pages of history. The brush, the pencil, and the chisel, attaining immortality, in some sort deal with universal law, formulated in objective teachings.

The lawyer reaches the highest professional eminence when he unites general knowledge with skill, learning, and the careful study of the principles of jurisprudence. Assiduous and unremitted application is the absolute essential for such triumphs. One finds in the history of statesmen, who have gained personal and public renown, and who rank with the great men whose posthumous fame lives in later generations, that their first preparations were in the study of the Pandects, the Institutes, the Civil and the Common law. Yet these names are unfrequent. The sword and the sceptre have cut into the tables of historic stone, the immortality of these rulers of peoples, and great leaders of victorious armies. The forum is the arena of peaceful antagonisms and contests in which the weapons are didactic skill, logic, reason and oratory.

Victories thus and there won are not declared by the display of ostentatious acclaim. In the quiet assertions of the deliberate and calm dominion of legal right, and ascertained justice, the supremacy of law is honored.

These reflections are eminently appropriate as preparatory to the notice of the death of one of our members, who, as a lawyer and a citizen held a pronounced position at the Bar of Philadelphia, and in public estimation.

Henry M. Phillips was born in Philadelphia, on the 30th of June, in the year 1811. Without large wealth, and its surroundings and influence, the lad early evinced a zeal and devotion to the shaping of his own career, which attracted even more than passing comment. He was a pupil in the most prominent school of that day, the "High School of the Franklin Institute." His quickness in acquiring knowledge was the leading trait in his academic life. There was apparently no trouble in his mastery of the subjects taught. It may be said that he ran through his course, until at its close he was with the foremost among his fellows.

There was no unanimity in the discussion of the pursuit best suited to the youth who had so early finished his school life. His father, a lawyer of remarkable prominence, and the acknowledged leader of the criminal bar of that day, did not wish his son Henry to study law. There were three sons, and it was thought but one should adopt the vocation of the father. But Henry, depending on his own ability as he measured it, was not satisfied till he became a student in his father's office. Before he had attained his majority, only twenty years of age, he was admitted to practice at the Philadelphia Bar.

It would be difficult now even to guess at the feelings of this young man who was thus placed in at least a trying and not very promising position, at his age, at that day, as an attorney at law in Philadelphia.

The Bar of Philadelphia was then admittedly the most remarkable of the law associations on this continent. It had become a popular adage, that no unsolvable problem would puzzle a Philadelphia lawyer. The Bar was lustrous with the most brilliant minds, and the roll of its members embraced not a few of the great jurists of that time. Masterly ability, profund learning, a high order of forensic eloquence, marked the golden age in its history.

Young Phillips at once began his legal career. The better to learn, he accepted the position of clerk in the Court of Common Pleas, presided over by a judge who has left a record of the most thorough mastery of jurisprudence, and wonderful ability. Judge King's name has few, if any, successful rivals in the profound respect of the bench and the Bar.

Under such daily tuition Mr. Phillips absorbed the principles of the law, and learned the truest method of their application. He became both an adept in practice, and the proper relations of precedents to cases. He was thus equipped for the contest before courts and juries. Very soon he held an assured place, and at the criminal bar and in civil courts he secured a substantial standing.

For nearly thirty years he advanced with progressive steps, till he reached the level of the leaders in his profession. The opinion of his brethren, as expressed at a meeting of the Bar, held October last, to honor his memory, is probably the best, if not the truest estimate of his professional and personal character that can be given.

This minute was unanimously adopted at that meeting:

"The death of Henry M. Phillips impels a sincere manifestation of the unfeigned sorrow of the Bar of Philadelphia. He was a man of rare qualities; a lawyer of striking and marked character; a friend of tried and true earnestness; a citizen of untiring devotion to all the duties imposed; faithful to every trust; of large and liberal views; he rose to a high rank in his profession as the associate of the great lawyers of this Bar, and was rightfully recognized as one of the foremost citizens of Philadelphia.

"The quickness and activity of his mind, his wonderful faculty of seizing, as by intuition, the strong points of his case, the force with which he elucidated them, the capacity for absorbing the principles of law which reported cases enunciated, his most singularly retentive memory, gave to

his professional career a distinction which was remarkable. His kindness to the young lawyers who asked his advice and legal aid was proverbial.

"Retiring from active practice his last years were devoted to public duties of a high order, and very much of his time was cheerfully given to advising and counseling in matters of individual interest and public importance. Such a character is worthy of memorial. Let it be inscribed on the scroll dedicated to our departed brethren of this Bar.

The last public occasion when Mr. Phillips took his recognized place as a member of the Bar was presiding at the Bar dinner given December 20, 1882, to the late Chief Justice of the Supreme Court of this State, Judge Sharswood, on his retiring from that exalted position. It was a memorable occasion. The Chief Justice was greeted by the profession he had honored, as a great jurist, whose professional, official, and private life ranked him among the ablest of the judiciary of our Commonwealth. Mr. Phillips thus with Judge Sharswood reached the end of their lives under the most appropriate surroundings. They both died in no long time thereafter.

Having acquired both reputation and an assured income, Mr. Phillips gave special attention to politics. Until both had been attained, he knew the unwisdom of intermitting attention to his vocation. Success at the Bar, success in any profession or business, is only secured by constant and unremitted application. A divided duty is half performed, or disregarded. This Mr. Phillips knew, and he patiently waited until he felt he could devote some time to other affairs. In 1856 he was elected from the 4th district of Pennsylvania to the Federal House of Representatives. He took his seat in the 35th Congress on December 7, 1857.

He was appointed on the Standing Committee on Elections, and had for colleagues the ablest lawyers in the House, John W. Stevenson, of Kentucky, L. Q. C. Lamar, of Mississippi, Israel Washburn, of Maine, James Wilson, of Indiana, and others.

Mr. Stevenson was afterwards elected Governor of Kentucky and United States Senator from that State, and Mr. Lamar is now in the Federal Senate from his State.

Mr. Phillips was also placed on the Special Committee on the Pacific Railroad, with John S. Phelps as chairman, and among his associates were Erastus Corning, W. S. Groesbeck, John A. Gilmer, O. R. Singleton, J. F. Farnsworth, &c.

It was thus that at the opening of his public life Mr. Phillips' reputation placed him among the foremost of our public men of that period.

His election to Congress was his first popular endorsement through the ballot box. His first step in the public arena was from the Bar to the Federal Legislature. Whatever of qualification he possessed for this trust was gained by that remarkable power of observation and absorption which emphasized his life. Instinctively he knew, or if he had to learn, he was preternaturally proficient. The method by which he acquired information and knowledge, attained what he sought, or what was required or necessary, is not easily explained. It was more an inherent faculty,

than a systematic process. It may be called a mental idiosyncrasy. However ill this may be as an explanation, yet it is the better description of Mr. Phillips peculiar mental temperament.

That Mr. Phillips devoted little, if any, time to general reading while actively engaged in his profession is known of all his friends. He wrote nothing on public questions, and indeed, made no contributions on current or special literary subjects. Yet his speeches in Congress were masterly and thorough on the questions he discussed.

On the 12th of June, 1858, he addressed the House of Representatives on "*The expenditures and revenues*" of the country, in which he discovered both knowledge and power, and made a mark as a debator. He met on this occasion in debate Mr. Sherman, of Ohio, then establishing his reputation. If he had not gained the ear of the House and impressed himself on the judgment of his colleagues as worthy of their consideration, a failure would not have been wondered at under the concomitant circumstances. That he did make a marked impression is known.

On the 9th of March, 1858, Mr. Phillips made a very able speech on "The admission of Kansas as a State under the Lecompton constitution." On this subject Mr. Phillips was in the line of his studies, and he manifested his familiarity with the questions involved in their discussion. That he made a deep impression on the House is shown by the record of the proceedings. He was very forcible, and ably presented his views, so much so, that Mr. Grow, Mr. Montgomery and Mr. Kunkel, of Pennsylvania, and Mr. Stanton, of Ohio, interrupted him to ask for information, and to support their understanding of facts, or to question the basis of his argument. Mr. Phillips was fortunate on all these occasions in strongly justifying his statements, or strengthening his positions. This speech, and the incidents attending its delivery, elevated its author to a position formidable in debate, and forcible in argument.

That Mr. Phillips had the faculty of acquiring knowledge by absorbing it as if without consciousness, can be affirmed from reading the two addresses to which reference is made. Entering Congress without any preparatory study of the business that was likely to engage the attention of the Federal Legislature; with no experience in public life; entrusted for the first time with the duties and responsibilities of a representative of the people; new in all its relations to his constituency and the country; surrounded by able and experienced statesmen; brought to the consideration of principles of the highest moment to the welfare of the United States, Mr. Phillips was able to discuss them with a self-reliance imperturbable, and a confidence in his own powers.

The two speeches to which notice has been called are selected out of his legislative record because the subjects are so wholly disconnected with each other, as more distinctly to demonstrate the view here taken of Mr. Phillips' character.

It was a remark often made by John W. Stevenson, his colleague in

Congress from Kentucky, afterwards governor of that State, and its representative in the Senate of the United States, one of the ablest and purest of the public men of this country, that Mr. Phillips was a very successful member of the House, and both in committee and on the floor was equal to any emergency. Governor Stevenson regarded Mr. Phillips' service on the Committee of Ways and Means in the 2d session of the 35th Congress, as proof of this estimate of his public character.

The proceedings of the House of Representatives for the sessions of the 35th Congress, as published in the *Congressional Globe*, prove the earnest, active part taken by Mr. Phillips on public questions, his aptitude in debate, his familiarity with and incisive mode of dealing with questions of parliamentary law. He was laborious in his attention to the business devolved on the Committee of Ways and Means, and faithfully served it by his watchfulness and promptitude, his comprehension of the questions under debate, and the facility with which he made his views understood by his colleagues in Congress.

The 35th Congress was remarkable not only for the character and attainments of so many of its members, but also from the questions with which it had to deal. That Mr. Phillips should have gained and maintained a prominent position during both its sessions is as likely as any other evidence to assure his deserved reputation.

On his retirement from Congress Mr. Phillips returned to his professional duties. For several years he was devoted to them, but from time to time he was induced to take an interest in matters of general public concern, and give his knowledge and experience for the benefit of his native city. He felt he ought to contribute his share to the welfare of Philadelphia, and from 1865 to 1875 he was engrossed in such service. Thus withdrawn from active practice, he became the counselor as he ceased to be the counsel. Though his advice and sound judgment were always sought, yet he confined himself to consulting and advising on subjects which were to be affected by the enactment of laws, as well as their determination and adjudication.

The city having been made the trustee under very many testamentary devises for objects of benevolence, and most especially by the will of Stephen Girard for purposes of the highest importance to the people of Philadelphia, especially, it was deemed advisable to unite the administration of these trusts in one body charged with this duty.

Mr. Phillips took great interest in this proposition. It was consummated, and on September 2d, 1869, he was appointed a member of this new organization, "The Board of City Trusts." Subsequently he was elected its vice-president, and then its president. His faithful and useful services in that board were fully recognized.

On the 16th of October, 1874, Mr. Phillips was selected as one of the directors of "The Pennsylvania Company for Insurance on Lives and Granting Annuities." His knowledge and experience qualified him for the discharge of the responsible duties of this position.

At the election of directors of the Pennsylvania Railroad Company, in March, 1874, Mr. Phillips was elected a director. He devoted very much of his time and attention to the responsibilities involved, with their ramified interests and urgent demands on his best judgment.

Desiring to aid in forming a correct taste, and encourage the love of music in Philadelphia, he was chosen as a director of the Philadelphia Academy of Music in 1870. His active exertions in the Board resulted in his election as its president in 1872. He resigned, however, from both in 1884.

The Court of Common Pleas on the 13th of May, 1867, appointed Mr. Phillips a member of the Board of Park Commissioners, and on March 12, 1881, he was elected president. He took a liberal view of the proper administration of this great public benefaction. His service on that board was earnest and important.

On the 4th day of December, 1862, Mr. Phillips was chosen a trustee of the Jefferson Medical College to fill the vacancy on the death of his brother, I. Altamont Phillips, likewise a member of the Philadelphia Bar. This medical school, with all its adjuncts for teaching and training in the curative art, with its world-wide reputation for the highest capacities in its faculty, and the substantial attainments of its graduates, called from Mr. Phillips anxious and continuous attention. Well did he devote it, not only with conspicuous assiduity, but with intelligent comprehension of its demands.

The Legislature of Pennsylvania passed, April, 1870, the law creating a commission entrusted with the erection of municipal buildings for Philadelphia. Mr. Phillips' advice was sought and his efforts enlisted to secure the legislation required. He was made a member of the commission by this act, approved by the Governor in August, 1870. On the 19th of October, 1871, he resigned.

At a meeting of our honored and venerable society held January 20, 1871, Mr. Phillips was elected a member.

In December, 1858, "The Grand Lodge of Free and Accepted Masons of Pennsylvania" elected Mr. Phillips Grand Master. In this distinguished station he made his administration creditable to himself and conservative of the interests of the craft. The duties devolved upon the Grand Master were in harmony with his character and acquirements, and the record of his term of service attests his fidelity to the trust, and sincere testimony of the appreciation of his brethren.

This is a brief narrative of Mr. Phillips' connection with some of the public institutions of Philadelphia, and it is obvious that such diversified duties as each placed on him, taxed his energies and absorbed his time.

So active a life was not likely to afford opportunities for the belles-lettres, cultivation of tastes, or the preparation of contributions to general literature. It is somewhat remarkable that no essay, treatise or paper on jurisprudence, literature, science or art, was ever prepared and published by Mr. Phillips. It is alike true that he never made a speech or public

address on subjects of public interest before a popular assemblage. This is so singular that to omit its mention would naturally invite criticism.

It was as remarkable that Mr. Phillips never visited any foreign country, or, indeed, any part of his own. He remained in Philadelphia, except short sojourns at Saratoga, or by the seaside during the summer months, yet he lived to the age of three-score years and twelve.

With traits of personal character that assured him devoted friends; kind, and more than considerate to the young lawyers who sought his advice in their first efforts; generous, when his left hand knew not the outgivings of the right; undemonstrative in his private relations; and retiring from a participation in social exactions; concerned for the happiness of those immediately connected with him by the nearest ties of kindred; living unmarried and without such domestic claims on his leisure hours; the public life of Henry M. Phillips is worthy of the respect which the American Philosophical Society desires by this notice to record and perpetuate.

Henry M. Phillips was a typical Philadelphian.

Those influences which surround the outgrowth of capacities in the men of high merit of our city, do not stimulate their appreciation by our own people. Our most distinguished citizens in literature, science, the arts and affairs, gain their fame by the recognition awarded by other communities. If perchance so fortunate, then Philadelphia, surprised at the discovery, permits its lethargic comprehension to utter tardy applause.

Biographical Sketch of Professor Samuel D. Gross, by J. M. Da Costa, M.D., LL.D.

(Read before the American Philosophical Society, December 19, 1884.)

Samuel Dent Gross was born in the neighborhood of Easton, Pennsylvania, on July the 8th, 1805. At school he was an industrious boy, and he received a good education at the Wilkesbarre Academy and the Lawrenceville High School. He never went to college; but when at the age of nineteen he began to read medicine, it was evident that the young votary of science had been accustomed to intellectual labor, and was taking up his professional studies with no untrained mind.

On enrolling himself as a student at the Jefferson Medical College, of Philadelphia, he was at the same time an office pupil of Professor George McClellan, if one of the most eccentric, also one of the most original and successful surgeons of his day; and it is very likely that young Gross, who through life preserved a veneration for his brilliant preceptor, got his bias for surgery from this association. And how he worked as a student! Tales are still current at the College, transmitted through janitors and college servitors, and losing nothing in coloring by the diffusion through

the successive classes the eminent professor subsequently taught, of how immense had been his labors; how he rose with the early dawn; was never seen without a book under his arm; and had to be turned out from the anatomical rooms by the wearied attendants when the hour for closing them arrived. Certain it is he worked with his whole heart; and when he graduated in 1828 he was a noted man in his class.

He began the practice of his profession in a little office in Fourth street, in Philadelphia, and it is said that he had among the visitors who dropped in on him his future colleague, Joseph Pancoast. More friendly visitors than patients, it is to be feared, came to his rooms; for after about two years, his patrimony being nearly spent, he gave up the struggle in a great medical centre and returned to Easton. But he carried with him evidence of his love of learning and of his indomitable perseverance. He had in the short time translated from the French and the German works on General Anatomy, on Obstetrics, on Operative Surgery, and he had published his treatise on "The Anatomy, Physiology, and Diseases of the Bones and Joints." He also took away with him a wife, a lady of English descent of many accomplishments, who proved to him a true helpmate in his arduous career.

It was not long before Dr. Gross became a leading practitioner in the flourishing little town of Easton, and his scientific knowledge was so well appreciated that he was offered the Chair of Chemistry in the well-known College there seated, in Lafayette College. He declined it; but finding that within him which impelled him to become a teacher, he relinquished his growing practice to accept the demonstratorship of anatomy in the Medical College of Ohio, at Cincinnati. His stay at Easton had not been barren in additions to his scientific acquirements. He was constantly at work in a dissecting-room which he built at the foot of his garden. Here, too, he made a series of most careful observations on the rapidity with which articles taken into the stomach are excreted by the kidneys; and investigated the temperature of the venous blood, which he found as an average to be 96° Fahr. Further, he wrote a considerable part of a treatise on descriptive anatomy, in which an English in place of a Latin nomenclature was employed. This work was never finished; the experiments on the blood were published at Cincinnati in the second volume of the Western Medical Gazette.

As a demonstrator in the Medical College of Ohio, which he joined in the autumn of 1833, Dr. Gross was very successful. But he did not long remain in this position; for after the work of two sessions he accepted the Chair of Pathological Anatomy in the Medical Department of the Cincinnati College. He threw himself with even more than his usual ardor into the subject, and the number of specimens he studied and collected was great, and the extent of his reading enormous. It was the pursuit of Pathological Anatomy, on which he gave the first systematic course delivered in this country, which made him so learned and skilled a surgical diagnostician, and he cherished through life a great devotion to the

branch. Nor was his association with it limited to the four years he taught it from the professor's chair. His "Elements of Pathological Anatomy," issued in 1839 in two octavo volumes of more than five hundred pages each, did more to attract attention to the subject than anything that had ever been done in this country. The book, illustrated profusely with woodcuts and with several colored engravings, reached three editions. It is a mine of learning, and its extended references make it valuable to this day. Its merits have been fully recognized abroad; and on no occasion more flatteringly than when the great pathologist, Virchow, at a dinner given to Dr. Gross at Berlin in 1863, complimented him publicly on being the author, and, pointing to the volume which he laid upon the table, gracefully acknowledged the pleasure and instruction with which he had often consulted it. As another acknowledgment of its merits, we find that soon after the publication of the second edition the Imperial Royal Society of Vienna made Dr. Gross an honorary member.

Dr. Gross remained six years in Cincinnati, popular as a teacher, and gradually acquiring a large general practice; but with a stronger and stronger predilection for surgery. It was this chiefly which led him to accept the Professorship of Surgery in the University of Louisville; and with the removal to Louisville in 1840 Dr. Gross' national reputation may be said to begin. Patients flocked in on him from all sides. He soon became the leading surgeon of the Southwest, being often called away long distances into the interior of Kentucky and adjacent States. He lived in a large house in a very hospitable manner, and with a young family around him the house was gay and pleasant, and a centre for men and women of mark.

But neither the claims of practice, nor the demands of social life, quenched his thirst for work. He published, besides many papers in the Western Journal of Medicine and Surgery, a most valuable monograph on the "Nature and Treatment of Wounds of the Intestines," which contained many original experiments and observations. He printed full biographies of Daniel Drake and of Ephraim McDowell,—the surgeon who had the boldness to be the first to perform ovariotomy, and through whose boldness, it has been computed, thousands of years have been added to human life. He wrote a lengthy report on the "Results of Surgical Operations in Malignant Disease;" published a treatise on "Diseases of the Urinary Organs," which soon became an acknowledged authority, and has passed through several editions; wrote a work on "Foreign Bodies in the Air Passages," from which all subsequent authors have largely copied their facts, and of which the distinguished laryngologist, Morrell Mackenzie, has declared that it is doubtful whether it ever will be improved upon. Part of all the enormous labors necessary to complete these and other literary undertakings was performed in New York, where Dr. Gross passed the winter of 1850–51, occupying the Chair of Surgery in the University of New York, which had been rendered vacant by the retirement of the then most famous operative surgeon of this country, Valentine Mott.

But, however pleasant he found the social life of the great city, he deemed it best for his own interests not to tarry there, and he returned to Louisville; his late colleagues received him with open arms, and his successor, Dr. Eve, with generous abnegation, retired to let him renew his teachings from his old chair. It seemed that nothing would again take Dr. Gross away from Louisville, where he became a very prominent citizen, in whose reputation all took pride. But in the spring of 1856 came the offer which he had not the heart to resist; the call from his Alma Mater to fill the Chair of Surgery, vacated by the most popular professor of the branch in this country; the idol of the largest classes then assembling in any medical school in America. To succeed Thomas D. Mutter was a trial to any one. But Dr. Gross, conscious of his powers as a teacher, in the prime of life and of vigor, ambitious to connect his name forever with that of the College where he had been educated and which a band of eminent men had made so flourishing, accepted the task without misgivings, and the result was unmixed success for himself and great benefit to the Institution. Many were the remonstrances against his leaving the home of his adoption, and he did so, he tells us himself in his inaugural address, against the inclinations and wishes of his family. Moreover, he was very loth to sever his connection with the University of Louisville "for sixteen years the pride and solace of my professional life." And it was the simple truth when he stated that in making the change and coming to Philadelphia, he, the most noted surgeon of the Southwest, had left behind him an empire of Surgery.

His inaugural address was very favorably received. His impressive voice, his splendid intellectual appearance, the earnestness and force of his words, the latent power which all his utterances and actions showed, carried away his audience; and when in solemn tones he spake these words of his peroration "Whatever of life, and of health, and of strength, remains to me, I hereby, in the presence of Almighty God and of this large assemblage, dedicate to the cause of my Alma Mater, to the interests of Medical Science, and to the good of my fellow-creatures," it was felt that a man of great strength and earnest endeavor had come among us.

Never were thoughts more faithfully put into action. Dr. Gross was indefatigable, and became a celebrated teacher, deeply devoted to the school, the reputation of which he enhanced greatly. Indeed, it may be said, without injustice to any one, that for years he was the most commanding figure and the most popular teacher in it. Nor is it enough to judge him only by those around him or who held similar chairs in other institutions. It is not the recollection of many acts of encouraging kindness from an older to a younger man; it is not the pride of a colleague in the great reputation of one to whom all looked up,—which makes the writer of these lines say that in his profession Samuel D. Gross takes rank with the very few of the most renowned teachers of his day. To assign him his proper position he must be named with the Hyrtls, the Trousseaus, the Pagets. Less finished in eloquence he may have been, but in

perspicuity and impressiveness and in influence on his hearers he was not one whit behind. Seeing him standing in his lecture room, you saw the man at his best. The learning, the method of his discourse, its clearness and fullness were not more admirable than the force and directness of the words which, uttered in his deep and agreeable voice, sank into the minds of his youthful audience. Years afterwards men whose hair was turning gray would cite the strong words of the lesson the great teacher had made part of the guiding thought of their daily lives.

His didactic lectures were probably his best, though his clinical discourses were also models of perspicuity. He was least happy in his addresses, delivered as introductories or valedictories, or on special occasions. During his long and busy life he wrote many of them, some of considerable historical value, such as the Life of Mott, of John Hunter, a discourse on Ambrose Paré, an oration in honor of Ephraim McDowell. As these discourses were always written out, he read them from manuscript. But he was not a good reader, and no one to hear him would suppose that it was the same man who, great professor that he certainly was, had, when speaking without notes to his class, their unflagging, devoted attention. Strange to say, too, for one who wrote so well, the addresses show faults which appear nowhere else. They do not possess the art of leaving things unsaid, hence there are at times repetitions in them, marring their general efficiency. They have force—for it was impossible for this strong man to do anything that has not force—but they lack literary perspective.

Nothing of the kind, however, appears in his scientific writings. On the contrary, they are as concise, as vivid as it is possible to be. Nothing but strong thoughts, nothing but clear words. And Dr. Gross acquired this excellent style to such perfection that he wrote pages without a single correction. A most critical proof-reader once informed the writer, that of all the authors he had ever known, Dr. Gross altered least, his proof was the cleanest, there was scarcely a correction to be made or suggested.

His literary pursuits were unremitting during his residence in Philadelphia. Memoirs, reviews, essays on surgical subjects appeared in rapid succession; no sooner was one done than another was under way. In conjunction with Dr. T. G. Richardson, he was for a time editor of a flourishing journal, the North American Medical Chirurgical Review. He was also editor of, as well as chief contributor to a volume bearing the title of "Lives of Eminent American Physicians and Surgeons of the Nineteenth Century." And in 1876, as a contribution to the literature of the Centennial year, appeared a lengthy and extraordinary learned history of American Surgery from 1776 to 1876. As an instance of the rapid manner in which, if necessary, he could work, may be mentioned, that at the outbreak of the Civil War, he composed a pocket manual of Military Surgery in nine days, which was largely used by the young surgeons in the service of the United States, was soon republished in Richmond and equally employed by the surgeons of the Southern armies. A Japanese

translation of this little work appeared in 1874, and is still in use among the military surgeons of this enterprising nation.

But the great work he completed in Philadelphia, one by which his name will be long remembered, is his "System of Surgery," a work of which the first edition was published in two very large, profusely illustrated octavo volumes in 1859, and which in 1882 reached its sixth edition. The labor on it, and on the successive editions which brought it up to its present perfection, was enormous. Rising early, working late, writing with an assiduity that only a man of his wonderful physique could have kept up, he generally gave from five to eight hours a day to the cherished project, no matter what the interruptions or whatever else he had to do. Often, too, he would think out, while driving about town on his professional visits, the subject he was engaged on, and commit these thoughts to paper, on his return home, before he took rest or food.

The treatise on Surgery has become everywhere a standard authority. "His work is cosmopolitan, the surgery of the world being fully represented in it," says the Dublin Journal of Medical Science. "Long the standard work on the subject for students and practitioners," is the verdict of the London Lancet of May of this year, on the twenty-three hundred and eighty-two pages of the last edition. A Dutch translation was issued in 1863.

Dr. Gross always took the keenest interest in every question relating to his own profession and in its honor and advancement. He was a very constant visitor at Medical Societies in various parts of the United States and in Great Britain. He was probably known personally to more physicians and men of science than any other man in the United States, and wherever he went he had many followers and admirers. Most of the prominent surgeons of England were his personal friends. His interest in Medical Societies never flagged, and late in life he became the founder of two very flourishing ones, of the Academy of Surgery of Philadelphia and of the American Surgical Association. He served as president of both. In 1868 we find him as President of the American Medical Association at its meeting in Washington; and in 1876 as the President of an International Medical Congress in session at Philadelphia. He was a member of most of the noted medical societies of this country, of the Academy of Natural Sciences, and of this Society. He was also a member of many learned societies abroad; among them, of the Royal Medical Chirurgical Society of London, the Clinical Society of London, the Imperial Medical Society of Vienna, the Medical Society of Christiana, the Royal Society of Public Medicine of Belgium.

But his highest foreign honors were conferred upon him by the three great English Universities. D.C.L. of Oxford, in 1872, at the one thousandth commemoration of the University; LL.D. of Cambridge in 1880, in the same list with Brown-Sequard, with Donders, with Joseph Lister; LL.D. of Edinburgh *in absentia,* a compliment the more marked since it was only shared with Tennyson and a few others of great distinction,—the renowned American Surgeon carried honors which

few of his countrymen have ever borne together. His welcome at Oxford on Commemoration Day was very enthusiastic. His commanding appearance made him conspicuous even among the distinguished men who surrounded him, and a lady who was present told the writer that she felt a glow of patriotic pride in witnessing his warm reception and hearing the flattering remarks his splendid bearing elicited. At Cambridge the Public Orator addressed him as "Patriæ nostræ ad portus nuper advectus est vir venerabilis quem inter fratres nostros Transatlanticos scientiæ Chirurgicæ quasi alterum Nestorem nominare ausim." Of American colleges, to their shame be it spoken, only two, Jefferson College in 1861, and the University of Pennsylvania in 1884, bestowed on him any honorary degree in recognition of his great literary and scientific merit.

In March, 1882, Dr. Gross found that his physical strength was scarcely adequate to the arduous labors of his chair, and, while mentally as fit as ever, he resigned his cherished Professorship of Surgery. The Trustees at once elected him Emeritus Professor, and it was a great gratification to him to find that, in dividing the chair into two, they selected his son, Dr. Samuel W. Gross, to fill one part of it.

The remaining years of Dr. Gross's life were passed in pleasant retirement, but not idly. He had for years in Philadelphia been busy as a consulting Surgeon, and in a large office practice, and to a certain amount of this he attended to the last, his great reputation bringing him still many a patient from a distance. He also wrote diligently on an autobiography, published a paper "On the value of early operations in Morbid Growths;" another "On the best means of Training Nurses for the Rural Districts," a subject in which he was much interested; and composed two essays, one of them, on "Wounds of the Intestines," but a few weeks before his death. His hospitality, his genial manners were the same as ever; nay, advancing years softened the whole man, and made him more benign and more and more beloved. He was delightful in his own home, always surrounded by friends, adored by his family. The best of fathers, he had the constant companionship and care of the most devoted of children.

In the autumn of 1883 he showed symptoms of a weak heart; his feet were swollen, partly from dropsy, partly from rheumatic gout, and he had a long attack of bronchial catarrh. But he improved and held his own fairly well, notwithstanding signs that his digestive functions were failing, until after a severe cold in March, these began to give way entirely, and he died of exhaustion, May the 6th, after a long and most trying illness, which he all along regarded as his last. The deepest sympathy and affection were everywhere expressed for him. Telegrams and letters came daily, inquiring after him; old pupils, busy men, traveled hundreds of miles to grasp him once more by the hand. To very many his death was a deep personal sorrow.

An autopsy, made at his own request, showed that the stomach and heart were degenerating. He had lived out the life of possible strength; to have lived longer would have been to enter upon a life of suffering. His death

saved him from protracted inaction and pain, from what Heine, in his own case, has pathetically bewailed as the "mattress grave." By special directions in Dr. Gross's will the body was cremated, and the ashes have been placed beside the coffin of his wife in Woodlands Cemetery.

Such is a sketch of the life of this prodigious worker. An original contributor to the science for which he had a fondness; a widely known practical surgeon; an admirable, most learned writer; a great teacher exerting an influence which will long survive him,—Dr. Gross occupied the foremost rank in the medical profession. It was evident from his student days that he was to be a man of rare distinction:

> "Mens ardua semper
> A puero, tenerisque etiam fulgebat in annis
> Fortunæ majoris honos."

He, certainly, was of the men whose high fortune throws its shadows before from the earliest years. The youth showed what the mature man was; the old man was but the youth with the promise fulfilled, and with honors gracefully worn that no one ever doubted would be attained. A part of his extraordinary fame is due to the circumstances under which he worked. He was the first writer on this continent who, with anything like gift of expression, brought together and elaborated the truths of surgical science, and partly this, but chiefly the excellence of his labors, extended his reputation in all directions beyond his own country. In acquiring fame for himself, he added to her fame. Conspicuous in many ways, Samuel Dent Gross stands forth a marked personality among the eminent men of our or of any generation.

Stated Meeting, Dec. 19, 1884.

Present, 15 members.

President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the University of California and the Royal Society of Victoria, Melbourne (112, 113).

Letters of envoy were received from the Argentine Observatory, the Department of Internal Affairs at Harrisburg, and Mrs. John Biddle of Philadelphia.

Donations to the Library were received from Mr. H. J. Browne of Victoria; the Bureau of Statistics at Stockholm;

the Royal Academy and Royal Observatory of Belgium; the Geographical Society at Paris; the Annales des Mines; the Lords Commissioners of the Admiralty, the Meteorological Council of the Royal Society, and London Nature; Mr. J. Lowthian Bell; Dr. Benjamin Ward Richardson; Mr. E. W. Maunder; the Natural History Society of Northumberland, Durham and New Castle-upon-Tyne; the Boston Society of Natural History; the Museum of Comparative Zoölogy; the American Society of Civil Engineers; Yale College; the Meteorological Observatory of New York; the College of Physicians; the Second Geological Survey of Pennsylvania; the Johns Hopkins University; the U. S. Bureau of Ethnology, and Coast and Geodetic Survey; Rev. Stephen D. Peet, of Chicago; the National Academy of Sciences, and the National Observatory of Cordoba. Also, a valuable set of books on India, bequeathed to the Society by the late John Biddle, Esq., of Philadelphia.

Mr. Vaux read by appointment an obituary notice of the late Mr. Henry M. Phillips.

Dr. DaCosta read by appointment an obituary notice of the late Samuel D. Gross, M. D.

Prof. Cope communicated a paper entitled "Twelfth Contribution to the Herpetology of Tropical America."

Mr. Ashburner described the recent publications of the Second Geological Survey of the State.

The Committee on two applications for the Magellanic premium reported adversely to the applications.

The report of the Finance Committee was read and approved, and the appropriations for 1885 recommended therein were adopted, and the meeting was adjourned.

The remarks of Mr. Ashburner were as follows:—

In 1874 the Second Geological Survey of Pennsylvania was organized. Up to the present time there have been issued sixty reports (edition of 5000 copies) of progress and eleven atlases of maps and sections, in octavo volumes, to accompany these reports. In addition to these, within the last month, there has been published a large atlas of unfolded sheets of the Anthracite Survey, constituting the first part of a series of similar atlases which will ultimately form the grand atlas of the survey. A copy of

this Anthracite atlas has been transmitted to the Society during the past week, and it may be of interest to the members to know something of the plan which has been adopted for the publication of these grand atlas sheets. The direction of the publication of these atlases has been placed under my charge.

Since the commencement of the Survey, there have been numerous sheets of geological maps and sections published to accompany the reports of progress. These sheets have been printed on light paper and folded in octavo atlases, or in a pocket of the reports. Anticipating a demand which might arise for copies, upon heavier unfolded sheets from which measurements could be made, of those maps and sections which were of a more permanent character, an edition (1000 copies) of such maps and sections has been printed on heavy atlas paper, the size of the sheets being 26 x 32 inches, except in one or two special cases. This size of sheet was adopted on account of its being that upon which the maps and sections could be most economically adjusted, and not as being a convenient one for handling.

The Grand Atlas has been divided into five divisions. Although all of the sheets to be contained in any one of these five divisions are not as yet printed, or even all constructed, it is proposed at the present time to issue, in individual parts, the sheets of each division which have been printed; as other sheets shall be printed under the five divisions respectively, they will constitute a second part of the same division. It is designed, however, not to issue a separate part of a division until the sheets shall aggregate twenty to twenty-five in number.

Division I will contain the geological maps of the counties constructed on a scale of two miles to one inch, 1-126,720th of nature. In the notes of explanation accompanying Part 1 of the county geological maps, containing forty-nine sheets, covering fifty-six counties, which is now in press, and which will shortly be issued, Prof. Lesley says: "None of these county maps are correct, and it is a rare occurrence that any two or three maps can be joined together to form one connected whole. The geology of the counties has been outlined on the maps from outcrops, located with reference to some topographical or geographical feature determined on the ground, the position of which appears on the map. As a result of this method, the geological outlines, at a line common to adjoining maps, do not always meet, the geology on each being referred independently to the topographical and geographical features of the two maps, which do not themselves agree along the common line. In some cases adjustments have been made, especially where the geology of several adjoining counties was mapped by one assistant geologist. In cases where topographical maps have been made by the Survey, the geology has been outlined on them, and that portion of the county map containing such surveys has been made to agree with them. Although it would be practically impossible to construct an accurate geological map of the entire State from a compilation of the county geological maps, yet it is apparent that when an accurate topo-

graphical map of the State from original surveys shall have been made, the geology can then be outlined upon it, by using the information contained on these maps, with very little additional work in the field."

Division II, will contain the sheets of the Anthracite Survey. These sheets will be grouped under the following heads:

Mine sheets, scale 800 feet to one inch, 1-9600th of nature. The area covered by each sheet, inside of the border lines, is 15.67 square miles. On these sheets will be represented the plan of all the mines and the shape of the floor of the most extensively developed coal bed (Mammoth bed principally), where mined, and its most probable structure in undeveloped areas, by contour curve lines fifty feet vertically apart; also the surface geological features.

Topographical sheets, scale 1600 feet to one inch, 1-19,200th of nature. The area embraced within the border line of each sheet is 62.68 square miles. On these sheets will be represented the topography of the surface by contour curve lines ten feet vertically apart.

Cross section sheets, containing vertical cross sections, scale 400 feet to one inch, 1-4800th of nature, showing the shape of the coal beds, where mined, and their most probable structure in undeveloped areas, accompanied by special maps and sections of the areas referred to, on various scales.

Columnar section sheets, containing perpendicular columnar sections, showing the thickness and character of the coal measures, scale forty feet to one inch, 1-480th of nature; and of the coal beds, scale ten feet to one inch, 1-120th of nature; accompanied by special sections and diagrams on various scales.

Miscellaneous sheets, containing special illustrations directly connected with the history, mining and geology of the region.

Division III, will contain the maps and sections relating to the petroleum and bituminous coal fields, published on various scales.

Division IV will contain the topographical maps, from the surveys of A. E. Lehman, of the South Mountain in Adams, Franklin and Cumberland counties, and the topographical maps of the Great Valley between Easton and Reading, constructed from the surveys of Messrs. d'Invilliers, Berlin and Clarke. These maps are published on a scale of 1600 feet to one inch, 1-19,200th of nature, and the topographical features are delineated by contour curve lines, either ten or twenty feet vertically apart.

Division V will contain the geological maps and sections relating principally to the Silurian and Devonian formations in Central Pennsylvania, and geological cross sections of the Philadelphia rocks in the south-eastern portion of the State.

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA, FOR PROMOTING USEFUL KNOWLEDGE.

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On the Language and Ethnologic Position of the Xinca Indians of Guatemala. By Dr. Daniel G. Brinton.

(*Read before the American Philosophical Society, October 17, 1884.*)

In the aboriginal ethnology of Guatemala, the affiliations of the Xinca tribe have always remained uncertain. The opinion is expressed by Dr. Stoll (*Zur Ethnographie der Republik Guatemala,* p. 170, Zürich, 1884) that an investigation of their language might throw a new light on the migrations of the ancient inhabitants of that region.

Up to the present time, however, no words of their language have been published, and students have had no means of comparing it with the dialects which surrounded them. I am fortunate enough to be able to supply this deficiency to a moderate extent, and to offer sufficient materials to form some opinion as to this people.

Their precise location was on the Rio de los Esclavos and its branches, which empties into the Pacific ocean, about N. lat. 13° 50′, W. long. 90° 25′,* and westward to the Rio Michatoyat. Their area embraced most of the departments of Santa Rosa and Jutiapa, and may roughly be said to have extended about fifty miles along the coast, and back to the Sierra some sixty miles.

On the west they were bordered by the Pipiles, of Aztec lineage, speaking a Nahuatl dialect not much corrupted ; on their north were the Pokomams, who belonged to the Maya stock, and on their east was a colony of Popolucas, a tribe supposed to have been related to the Mixes of the Isthmus of Tehuantepec.

Their name has been variously spelled, Xinca, Xinka and Sinca. The first given is correct, the initial X having the value of the soft English *sh,* as in *show.*

According to the *Geografia de las Lenguas Maya-Kiche,* MS. of Dr.

Berendt, the Xinca is or was spoken in the following towns or villages in the district mentioned:

Atescatempa,	Mustiquipaque,
Atiquipaque,	Nancinta,
Chiquimulilla,	Sinacantan,
Comapa,	Tacuilula,
Guazacapam,	Taxisco,
Ixguatan,	Tepeaco,
Jupiltepeque,	Tescuaco,
Jutiapa,	Tupitepeque.

The first information about the Xincas is contained in the letter of Pedro de Alvarado to Hernan Cortes, dated July 28, 1524.* He there describes his conquest of their territory in the previous winter. Further particulars of the campaign are given by Juarros, in his *Historia de Guatemala*, Tom. ii, Tratado iv, Cap. xxii, from the MSS. of Fuentes.

From these sources we learn that Alvarado first encountered the Xincas after he had crossed the River Michatoyat and entered the town Atiquipaque (*Atiepar*, in Alvarado's letter, who makes as much havoc with the native names as he did with their armies).

In this town he particularly states that he met another people and a different language from those he had just left ("este es otra lengua y gente por si").

Thence he proceeded to Tacuilula and Taxisco, not encountering determined opposition, as Juarros erroneously says, as Alvarado informs us that the natives received him without fighting, but fled in the night to the forests. After leaving Taxisco, however, they attacked him in force and slew many of his allies.

The chief town of the Xinca would seem to have been either Nancinta (the "*Nacendelan*, pueblo muy grande" of Alvarado's letter) or according to Juarros, Guazacapam. In this vicinity a determined stand was made by the Indians, and they caused the Spaniards and their allies much trouble by digging pitfalls, and by planting the paths with sharpened sticks said to be poisonous. What puzzled the Spaniards was that these natives during their fighting held in their hands small bells with which they made as much noise as possible. Probably they were intended either as charms, or to alarm the enemy.

Juarros adds that these tribes were not conquered by Alvarado's incursion. It required renewed efforts by Don Pedro Portocarrero, in 1526, to bring them under subjection.

On account of their obstinacy, numbers of them were sold as slaves and branded with a hot iron, and hence was derived the Spanish name of the river on which the Xincas lived, *Rio de los Esclavos*, Slave river.

Very few hints as to their social condition are found in the early

*I quote it as published in the *Biblioteca de autores Españoles*, Vol. xxii, Madrid, 1852.

accounts. Their country is stated to have been populous, their towns built of wood and not of stone, they were skillful with the bow and arrow, and were bold warriors. They formed small independent tribes united in a sort of confederacy, the "cabeza de señorio," or chief clan, being at "the famous town of Guazacapam," and its four dependents or allies are named as,

Nestiquipaque,	Guaimango, and
Chiquimulilla,	Guanagazapa.

The linguistic materials I offer are vocabularies of three dialects of the Xinca.

The first, from Sinacantan, was obtained from a native of that place by the distinguished historian and antiquary, Don Juan Gavarrete, of Guatemala, in 1868. The other two were obtained for him in the same year by Don Sebastian Valdez, Cura of Jutiapa. As according to Dr. Stoll, the originals of these have disappeared, no one knows where, since Señor Gavarrete's death, the present publication seems the more appropriate, presenting as it does the only specimens of the Xinca language known to be in existence. I would not omit to add that they came into my hands, together with other valuable documents, in the collection of the late Dr. C. Hermann Berendt.

Phonology of the Xinca.

The language is vocalic, and with few gutturals or harsh palatals, contrasting in this respect with the Cakchiquel and other Maya dialects. The labials, *b*, *f*, and *v*, are absent, although *b* is found in two or three words of the accompanying vocabulary. The linguals are not prominent, the *d* and *th* not appearing at all. The semi-vowels *r* and *l* are convertible in the dialects and occasionally alternate with *n*.

In the vocabularies, the letters have the powers of the Spanish alphabet, except that *x* is pronounced like *sh* in *she*, the *v* is the neutral vowel as in *but*, the *z* is the same as the *s*, and the compounds *csh* and *sch* appear to have the value of the *x* (= sh).

Vocabulary of the Xinca Language.

LOCALITY.	*Sinacantan.*	*Jupiltepeque.*	*Jutiapa.*
Man,	jurac,	jumu,	jurgaqui.
Woman,	ayala,	aya,	aiya.
Boy,	xurum,	sorone,	soroni.
Father,	tatan,	tataj,	tataj.
Mother,	utan,	utaj,	utac.
Son,	najuum,	nauij,	naguij.
Daughter,	jaya najuun,	—— ——	naguij
Brother,	xuyam,	keruke,	suyac.
Head,	jamatan,	usajle,	gesalia.
Hair,	mux jumatan,	mosal,	musal.
Eyes,	jurtin,	juratii,	yuratica,

Locality.	*Sinacantan.*	*Jupiltepeque.*	*Juliapa.*
Nose,	jutu narin,	—— ——	narica.
Nostril.	uona narin,	—— ——	lurate.
Ear,	maman,	mami,	manca.
Mouth,	xa'jan,	xajac,	sajac.
Tongue,	ejlan,	ela,	eglajac.
Teeth,	jari xa'jan,	—— ——	sajac.
Throat,	ta'tam,	—— ——	tarti.
Breast,	ziquim,	tutu,	—— ——
Arm,	pum,	paja,	paja'.
Hand,	jixi pum,	pu,	puj.
Fingers,	mux,	pere pu,	pere puj.
Belly,	jiguin,	ururi,	ururi.
Leg,	titan,	kegüe,	uapi.
Knee,	jaricomon,	sulna,	—— ——
Foot,	ŭapan,	uapi,	guapi.
Town,	machiname,	saguqui,	saguqui.
House,	macu,	—— ——	macu.
Bed,	a'tac,	alutu,	alutaj.
Hamack,	guaro,	—— ——	guaro.
Mortar (mill stone),	uiki,	uik,	uic.
Plate,	aulac	aljuat,	augeal.
Jar,	erec,	—— ——	erec.
Fire,	uray,	uu'ra,	icura'.
Water,	ui,	—— ——	huy.
Maize,	aima,	—— ——	ahua.
Ear of maize,	—— ——	—— ——	aima.
Bean,	xinac,	sicna,	'cshidna.
Salt,	tita,	—— ——	tila.
Hat,	ta'yuc,	—— ——	tayuc.
Breeches,	xu'nan,	asuna,	asiuna.
Paper,	papooc,	papu,	popoque.
Heaven (sky),	uina,	—— ——	güigna.
Sun,	pari,	parri,	parri.
Moon,	agua,	—— ——	ahua.
Star,	xune,	hueso,	güeso.
Day,	pari,	ti parri,	ti parri.
Night,	chamazwma,	chijmac,	schugmac.
Wind,	tan,	una,	yeuha.
River,	xanjui,	tire,	ture.
Hill,	naguona,	kerter,	querter.
Woods,	jaragua,	casagua,	caragua.
Road,	tasma,	talma,	talma.
Cornfield,	uaya'a,	uayaaj,	guaya'.
Earth (land),	naro,	narro,	narro.
Stone,	jixi,	ixe,	gicshe.

Locality.	*Sinacantan.*	*Jupiltepeque.*	*Jutiapa.*
Tree,	jutube,	utis,	utu'.
Ceiba,	pa'guac,	—— ——	—— ——
Banana,	jugua,	—— ——	—— ——
Jaguar,	uijlay,	uilay,	guilai.
Deer,	tuma,	—— ——	tubma.
Jabali,	cargua jaxo,	—— ——	—— ——
Dog,	pelo,	—— ——	—— ——
Snake,	jurumuy,	urunugui,	urunugüi.
Fish,	seema,	samu,	giamuc.
God,	tiuix,	—— ——	—— ——
Soul,	terouala,	namasamac,	—— ——
Alive,	ixiuac,	ixij,	isig.
Dead,	teroa'ar,	tero',	tero'.
Old,	merc,	mochi,	mochi.
White,	mooti',	moatij,	mougua.
Black,	zumati,	simatij,	sijmatig.
Red,	tenati,	tenajtij,	tenajtig.
Yellow,	meelati',	totojtij,	—— ——
Green,	mee,	meyatij,	meyatij.
Blue,	mee,	—— ——	—— ——
Bright,	minabar,	—— ——	—— ——
Dark,	zama,	—— ——	—— ——
Above,	xam,	—— ——	—— ——
Below,	xama',	—— ——	—— ——
Yes,	jaa,	—— ——	—— ——
No,	xim,	—— ——	—— ——
Good-day,	—— ——	—— ——	cshi mani maqui con Dios.
Good-night,	—— ——	—— ——	cshi manusiguai con adios.
Good-bye,	—— ——	—— ——	coo-par.

Numerals.

1.	ica,	ical,	ical.
2.	ti,	piar,	pia'r.
3.	uala,	ualar,	guarar.
4.	jiria,	iriar,	iriar.
5.	poj,	pijar,	pujar.
6.	tacal,	——	tacalar.
7.	pujua',	puljar,	pulluar.
8.	tapoc,	apuj,	apocar.
9.	uxtu',	——	gerjsar.
10.	pakil,	——	paquilar.

COMMENTS ON THE VOCABULARY.

Man. *Jumu.* In the Xicaque language of Honduras *jome* = man, but as this is the only close similarity in a comparison of thirty seven words, I attribute it to accident; *jurac* has a faint resemblance to Cakchiquel *hun uinak,* one man.

Father. *tataj,* is evidently the universal baby word for father, and its analogies are worthless for tracing affinities. The same is true of *utaj,* mother. Compare Germ. *Vater, Mutter,* Cakchiquel *iata.*

Son. *najuum,* in Pokomchi *akun,* probably an accidental resemblance.

Daughter. *jaya najuun, jaya* evidently from *aya,* woman, female, hence "female child," the combination showing that *najuun* does not mean son, but child, offspring.

Brother. *xuyam* and *keruke* are evidently wholly different words, and are either used by the different sexes, or apply the one to an elder the other to a younger brother.

Hair. *mux jumatan* (the last word no doubt an error for *jamatan,* literally "the fingers of the head" or more properly "the extremities, the small branches of the head"). See Fingers. *musal* is apparently a synthesis of *mux,* and *gesalia,* with the same signification. Such compounds indicate that the Xinca is more synthetic than the Maya dialects.

Nose. *narin, narica,* may be the Spanish *nariz,* nose.

Teeth. The words *xa'jan* and *sajac,* mean mouth. The prefix *jari* seems to mean either bone, or front part, as it re-occurs in *jaricomon,* knee (knee-cap ?).

Breast. *tutu* may be Spanish *teta,* but in the Maya dialects we find Cakchiquel and Quiche *tu,* tit, mamma. Pocoman, *tuj,* Chol., *txu ; ziquim* may be related to Quiche *tz'um,* mamma.

Hand. *jixi pum,* probably "the end of the arm." In none of the Maya dialects is there any separate word for "hand." The hand and arm are included in one term, the proper translation of which is "the upper extremity." When it is desired to distinguish between hand and arm, a compound must be formed, or the distinction be left to the hearer. *Jixi* is also given for stone; perhaps the stone point or end of the arrow explains the identity of the expressions.

Fingers. On *mux,* see teeth. *pere pu,* from *pum,* upper extremity, and a prefix probably signifying ends, tips, or branches.

Leg. *uapi,* means foot, q. v.

Knee. See teeth. The two words given evidently mean different things.

Foot. *uapan.* Comp. Cakchiquel *akan.*

Town. *machiname.* This is plainly the Pipil *chinamitl,* town, with a prefix *ma.*

Mortar. Span. *piedra de moler,* the hollowed stone on which the women pound the corn.

Plate, in the original, *comal,* from Nahuatl *comalli,* a shallow earthen dish used to prepare tortillas.

Maize. The word *aima* given for maize and ear of maize is found in precisely the same form in Chontal, and in Lenca *ama*. I am inclined to derive it from *ixim* (pronounce *ishim*) the universal word for maize in the Maya family. Later, we have for corn field *uaya'a*, which is close to the Cakchiquel *auan*, cornfield, or *auex*, when the corn is young. If this is correct, it would indicate that the neighboring tribes learned the cultivation of corn from the Maya stock, which is the more significant as it is now the opinion of botanists that the native habitat of the *Zea mais* was in Guatemala where it was developed artificially from the wild *Euchlæna luxurians*. The other word given for maize, *ahua*, is identical with that for "moon." This may possibly refer to an identification of the moon as the goddess of maize. In Chipeway the name of maize is *mandamin*, "the grain, *min*, of the god, *manito*."

Beans. *xiñ'ac* is the Cakchiquel, *tzinak*, Tzendal *txenek*. Evidently the Xincas got their corn and beans first from their neighbors of Maya lineage.

Salt. *tita*, from Nahuatl *iztatl*. This article the Xincas learned from their Nahuatl speaking neighbors, the Pipiles.

Breeches. All three words are corruptions of the Spanish *calzones*.

Paper. The words are corruptions of Span. *papel*.

Heaven or Sky. *uina'*, closely allied to Zotzil *uinaje'l*.

Sun and Moon. In pure Maya the general root for sun is *ki*, for moon, *u*. But in the Kekchi, Pokomchi and Pokomam we have for moon the totally different word *po*. This seems to be the radical of *parri*, sun, in Xinca. Further, in Chañabal and Mam we have for moon *ixa'u*, where the *ix* is probably the feminine prefix, leaving for moon *a'u*, a kin to Xinca *ahua*.

The word *ahua* bears a superficial resemblance to *huy*, water, but a close examination of these tongues does not bear out Dr. Trumbull's theory, of a radical connection between the expressions for sun and water. (See *Proceedings of the American Philological Association*, 1875–6, p. 45.)

Star. *xune*, allied to Cakchiquel, *tzûmil*, star; *hueso* appears to have no connection with Maya dialects.

Day. *pari*, the same as sun.

Night. *chijm—ac*, Cakchiquel *aka*, night, perhaps with the preposition *chi*, at, "by night," "at night."

Wind. *yeuha*, Pokonchi *te'ug*.

Tree. *utis*, Tznedal *te*, Chol *tie'*.

Jaguar. *uilay*, Pokomchi, *baijlam*.

Deer. *tuma*, Chontal, *chima'*.

Jabali. *cargua*, from *caragua*, woods, *jaxo*, Pokomchi, *aj'k*, hog, wild hog; compare the name of the same animal in Pokomchi, *quiche ajk*, wood-hog.

Dog. *pelo*, Spanish, *perro*.

Soul. *terouala*, in which *tero* is the adjective "dead."

Alive. *ixij*, Aguacateca, *itzin*, Tzendal, *c'uxul*.

Old. *mochi*, Maya, *noixib*, Tzotzil *mo'ol*.

Colors. The names of all the colors differ totally from the Maya. They appear to have a generic suffix, *ati*, appended to the radicals

mo, white.	*teu*, red.
sim, black.	*tot*, yellow.

me, blue or green.

The word *meelati* for yellow is probably a mistake, and the identification of blue and green is common in the radicals of most Central American tongues as I have elsewhere pointed out (*The Names of the Gods in the Kiche Myths*, *Proc. Am. Phil. Soc.*, 1881).

For comparison I add the Maya radicals for colors, as presented in the Kiche dialect.

zak, white.	*cak*, red.
gek, black.	*gán*, yellow.

rax, blue or green.

It is evident that there is not the slightest relationship, and they are equally remote from the Pipil and Aztec color names.

Numerals. The numerals indicate few and faint similarities to any of the other Central American or Southern Mexican languages with which I have compared them; *ica*, one, is like Mangue *tica*, and the four first may be compared with the Lenca of Honduras as follows:

XINCA.	LENCA
1. ica,	ita.
2. piar,	pe.
3. uala,	lagua.
4. jiria,	aria.

But I regard this as accidental, as it is not borne out by the remainder of the Lenca vocabulary, in four dialects, which I have brought into comparison.

The termination *ar* in the Jalapa dialect reminds one of the suffix *uual*, indicating turn or repetition, found in the Ixil numerals, a rather pure Maya dialect, thus:

ungvual,	one time.
cavual,	two times,
ox ual,	three times, etc.

God. *tiuix*. Gavarrete appends the note to this word: "It does not properly signify God, but image or idol. At present it is applied to the images of the saints." It is probably from the Cakchiquel *tioh*, great, divine, a word employed in a religious sense. This indicates the origin of their ancient cult.

The number five, *puj-ar*, is clearly the noun *puj*, hand, and refers to the five fingers.

Six, *tacal,* appears to be a compound of *ti-ical,* = second, first, *i. e.*, the first finger of the second hand. In seven, *puj-ua,* and eighth, *a-puj,* the word *puj,* hand, is apparently present.

From this analysis I reach the conclusion that the Xincas belonged to a different linguistic stock from the Mayas or the Pipiles (Nahuas). They were a rude tribe, who first learned the planting of corn and beans from the Cakchiquels or Pocomams, some parts of their religious rites from the same, the use of salt, and some of their village organization from the Pipiles, and portions of their present dress from the Spaniards.

They spoke a vocalic language of monosyllabic radicals, whose themes are chiefly formed by suffixes.

It may be that they were the rude primitive folk who once extended over Guatemala and were forced down to the coast and into the restricted limits were they were first found, by the warlike immigration of the Maya and Nahua races, both of whom distinctly remembered a foreign origin.

We know little of the date of the advent of the Cakchiquels and Pocomams into Guatemala. But a traditional history of it is preserved in the "Annals of the Cakchiquels," written shortly after the Conquest by Francisco Ernantez Arana Xahila, the original MS. of which is in my possession. He informs us that when his ancestors entered Guatemala large tracts of it were uninhabited, and other portions were peopled by a race who, even to the Cakchiquels, appeared as barbarous, and so rude that they called them *chicop,* brutes. They had captured two of these, and learned some words when they entered the lower country. The annalist proceeds:

"They [*i. e.* the ancestors of the Cakchiquels] descended finally to Cholumag and Zuchitan. The language there was very difficult, and only the barbarians themselves could speak that language. We spoke only as we had asked the barbarians Loxpin and Chupichin [their captives], and we said on arriving '*uaya, uaya, ela opa.*' The barbarians were greatly astonished to hear us speak their language with the natives of Cholumag; they were really frightened at it; but they gave us only good words."

From these few words, the meaning of which I do not know, it is evident the language was of a totally different stock from Maya or Nahuatl. It was soft and vocalic, like the Xinca; and, indeed, *ela,* tongue (language?), is found in the vocabulary. Unfortunately, Xahila does not tell us the signification of the phrase he gives. It was probably some form of friendly salutation.

But it is not worth while to pursue the inquiry further. These suggestions will indicate the interest which attaches to the Xinca tongue and will, I hope, inspire some one to obtain more complete information about it.

Stated Meeting, January 2, 1885.

Present, 12 members.

President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from Prof. Alexander Winchell (115); Smithsonian Institution (115); and L'Academie des Sciences, Lisbonne (Trans. N. S. XVI., i., and Proc. 112, 113).

Letters of envoy were received from the Department of the Interior, Washington, D.C., and the Hamilton Association of Canada.

Donations for the Library were received from the Geological Survey of India; the Society of Naturalists at Riga; the Batavian Society of Experimental Philosophy; the Royal Academy of Belgium; the Royal Academy of History at Madrid; the Royal Astronomical Society; Mr. E. W. Maunder, Mr. John Evans and Sir Richard Owen, of London; the Hamilton Association; the Boston Society of Natural History; the American Journal of Science; the Chemical Society of New York; Vassar Brothers' Institute; the Academy of Natural Sciences and the Library Company, of Philadelphia; Dr. Persifor Frazer; Mr. Henry Phillips, Jr.; Haverford College; the American Journal of Philology; Johns Hopkins University; the U. S. Naval Observatory and the Department of the Interior.

A letter was received from Gen. Hazen, Chief Signal Officer, U. S. A., requesting a copy of the Society's Catalogue, which was ordered to be sent.

A letter was received from Alfred Hölder, Vienna, notifying the Society that he could supply the residue of "Die Gasteropoden * *, von R. Hoernes and M. Auinger."

Prof. E. D. Cope made a communication on the Fossils of the Miocene Period of the Dominion of Canada, and exhibited specimens of the same.

Dr. Daniel G. Brinton read a communication entitled "The Lineal Measures of the Semi-civilized Nations of Mexico and Central America."

Pending nominations, Nos. 1031 to 1049 inclusive, were read.

The report of the judges of the annual election was read, and the following officers were declared duly elected for the ensuing year, 1885:

President,

Frederick Fraley.

Vice-Presidents,

E. Otis Kendall, Pliny E. Chase, W. S. W. Ruschenberger.

Secretaries,

George F. Barker, Daniel G. Brinton, Henry Phillips, Jr., J. Peter Lesley.

Councillors for three years,

Aubrey H. Smith, George R. Morehouse, Charles A. Ashburner, Edward D. Cope.

Councillor for one year, in the place of Robert E. Rogers, deceased,

Persifor Frazer.

Curators,

George H. Horn, Philip H. Law, Charles Gordon Ames.

Treasurer,

J. Sergeant Price.

Nominations for Librarian being in order, a letter was read from Prof. J. P. Lesley declining a renomination; whereupon Mr. Henry Phillips, Jr., was nominated for the position of Librarian.

The following resolution was then offered by Mr. J. Sergeant Price:

Resolved, That the members of the Society learn with regret of Prof. Lesley's determination of declining a renomination as Librarian, a position which he has occupied for twenty-two years, and they desire to express to him and to place on record their appreciation of the great value of his services to the Society.

Remarks were made by Messrs. Price, Brinton, Ashburner and the President of the Society, bearing witness to Mr. Lesley's zeal and activity in his office, and expressing their regret that his health and avocations would no longer permit him to continue in his position. The resolutions were then unanimously adopted, and ordered to be engrossed and forwarded to Prof. Lesley.

The Committee of Publication reported in favor of publishing the Dictionary of the Lenapi language, by Zeisberger, at a cost for its preparation not to exceed three hundred dollars. The report was accepted, and the Society ordered the publication of the same, referring to the Finance Committee the consideration of the question of ways and means.

Prof. Cope offered the following resolutions, which were seconded by Dr. Brinton, and adopted:

WHEREAS, The cause of education in science is retarded by the restrictions placed by Congress on the importation of scientific books and apparatus; whereas we believe that advance in the arts and industries depends on the development ot science, and is impeded by the before-mentioned import duties, and that all restrictions on education and scientific research are unworthy of enlightened government; whereas the scientific books published abroad are absolutely essential to students and investigators, and are but rarely duplicated in this country; whereas the value of scientific apparatus is in nearly all cases dependent on the individuality of the maker; and whereas colleges and incorporated institutions are now per-

mitted to import apparatus duty free, while private investigators, usually less able to afford expense, are obliged to pay duty, therefore

Be it Resolved, That the American Philosophical Society hereby requests the representatives of the State of Pennsylvania in the Congress of the United States to use all possible efforts to have placed on the free list books pertaining to the physical, natural and medical sciences, and apparatus intended for purposes of scientific research or of education, and further be it

Resolved, That a copy of these preambles and resolutions be forwarded to each member of Congress from the State of Pennsylvania.

And the meeting was adjourned.

Stated Meeting, January 16, 1885.

Present, 20 members.

President, Mr. FRALEY, in the Chair.

Donations for the Library were received from the Mining Department at Melbourne; the Academy of Arts and Sciences at Batavia; the Royal Asiatic Society; the Royal Academy dei Lincei; the Geographical Society at Paris; the Revue Politique; the Meteorological Society and Meteorological Council at London; the Journal of Forestry; London Nature; the Geological and Natural History Survey of Canada; the Boston Society of Natural History; the Museum of Comparative Zoölogy; the American Chemical Society; Mr. R. R. Bowker, New York; Mr. C. E. Beecher, of Albany; the American Journal of the Medical Sciences; the College of Pharmacy; the Franklin Institute; Mr. Henry Phillips, Jr.; Dr. E. W. Syle; the American Chemical Journal; Johns Hopkins University; the Treasury Department; the Chief Signal Office; the United States Commission of Fish and Fisheries; Mr. Jed. Hotchkiss, of Staunton, Va.; and the Minnesota Historical Society.

Mr. Henry Phillips, Jr., deposited in the Library "The Numismatic Chronicle and the Journal of the London Numismatic Society," 1882, Parts 1, 2, 3, 4; 1883, Parts 1, 2, 3, 4; 1884, Parts 1, 2, 3.

Dr. Syle presented the "Common Prayer" in Chinese, published in Philadelphia and printed in New York in 1884; also a Japanese adaptation of Kindergarten songs, published in Tokio in 1884.

Dr. Curwen read an obituary notice of the late Dr. Thomas S. Kirkbride.

Dr. George A. Koenig presented a communication entitled a "Note on Cosalite, Alaskaïte and Beegerite."

Dr. A. S. Packard, Jr. (of Providence, R. I.), presented (by letter) a communication "On the Embryology of *Limulus polyphemus*, III."

Prof. Pliny E. Chase read a paper "On the Results of an Important Weather Forecast."

Mr. Blasius read a paper "On the Brilliant Sun-glows of the Autumns of 1883 and 1884," which was followed by some remarks by Dr. Syle relative to the well-known sunsets in the tropics and equatorial regions, where moisture was usually most abundant.

Mr. Henry Phillips, Jr., was elected Librarian for the ensuing year.

The following new members were elected:

Prof. Lyman B. Hall, Haverford College, Pa.

Dr. Albin Weisbach, Freiburg, Saxony.

Prof. James W. Moore, Lafayette College, Easton, Pa.

Hon. Samuel J. Randall, Philadelphia.

Hon. George L. Harrison, Philadelphia.

Mr. Frederick Gutekunst, Philadelphia.

Mr. Edward H. Weil, Philadelphia.

Mr. Samuel Wagner, Philadelphia.

Mr. C. Stuart Patterson, Philadelphia.

Dr. Theophilus Parvin, Philadelphia.

Prof. George Inman Riché, Central High School, Philadelphia.

Prof. Francis A. Jackson, University of Pennsylvania, Philadelphia.

Prof. Wm. Osler, University of Pennsylvania, Philadelphia.

Mr. George B. Roberts, President of the Pennsylvania Railroad, Philadelphia.

Mr. Thomas Hockley, Philadelphia.

Dr. James C. Wilson, Philadelphia.

Prof. J. W. Mallet, Jefferson College, Philadelphia.

Prof. Samuel W. Gross, Jefferson College, Philadelphia.

New nomination No. 1049 was read.

The following Standing Committees were chosen for 1885:

Finance,

Henry Winsor, J. Price Wetherill, William B. Rogers.

Publication,

Daniel G. Brinton, Charles M. Cresson, George H. Horn, Persifor Frazer, J. Blodgett Britton.

Hall,

J. Sergeant Price, William A. Ingham, Charles G. Ames.

Library,

Henry Phillips, Jr., Edwin J. Houston, William V. McKean, Thomas H. Dudley, John R. Baker.

The Treasurer presented the annual report of the Trustees of the Building Fund.

And the meeting was adjourned.

The limits of stability of nebulous Planets, and the consequences resulting from their mutual relations. By Prof. Daniel Kirkwood.*

(Read before the American Philosophical Society, November 21, 1884.)

To determine the height of the atmosphere is a problem of no common difficulty. This is evident from the fact that estimates derived from the phenomena of twilight, luminous meteors, and the aurora borealis have been widely various. It cannot extend, however, beyond the limit at which its elasticity is counterbalanced by the force of gravity—a limit probably not less than two hundred miles from the earth's surface. Even the volume and weight of this atmospheric envelope are not absolutely constant, as small quantities of gaseous matter are doubtless brought into it from time to time by meteors and meteoric streams. Nor has this accession of matter from without been the only source of variation; it has been shown by several writers that the extent and density during the cycles of geologic time were in all probability much greater than at present.

But whatever the mass or density of the earth's gaseous envelope, an absolute limit—corresponding to the earth's present time of rotation—may be assigned it. "The atmosphere," says Laplace, "can only extend itself at the equator to the point where the centrifugal force exactly balances the force of gravity; for it is evident that beyond this limit the fluid would dissipate itself." This limit for the earth is 26,240 miles from the centre; for Saturn it is within the system of rings; and for the sun it is at the distance of sixteen millions of miles. These distances, however, were obviously greater before the members of the system had contracted to their

* A preliminary discussion of equation (1) in the following paper was given in the Analyst for January, 1881. Those solutions are here revised, and the results for each planet carefully determined.

ERRATA IN PROF. KIRKWOOD'S ARTICLE.

Page 106, erase the comma at the end of l. 2 from top.

" " l. 10 from top, for 489,000,000, read 480,000,000.

Page 111, l. 16 from bottom, for period read periods.

Page 112, l. 7 from bottom, for n' read n^2.

present dimensions. It is now proposed to find their original or maximum values.

In astronomy, as in other branches of physical science, many well-known facts remain still unexplained. This is true not only in regard to the fixed stars and the nebulæ, but within the narrower limits of the solar system. Recognizing the impossibility of accounting for present relations without considering the causes which operated in the distant past, astronomers have attempted to trace the process of formation from the primal chaos down to the origin of the youngest planet. In the theory of Laplace, the planets were formed from nebulous rings successively abandoned in the plane of the solar equator. The present writer, while not rejecting the nebular hypothesis itself, has indicated certain objections to the special form in which it was proposed by its celebrated author.* These difficulties, encountered in the theory of formation from *rings*, are avoided by supposing each planet at its origin to have been separated from a very limited arc of the equatorial protuberance. In either case, however, the dimensions of the primitive planet would be necessarily restricted by the law of gravitation.

It is sufficiently obvious that an original planetary mass in a nebular state could not have retained its continuity of form beyond a certain determinable limit; in other words, that it would have been changed into a ring by the attraction of the central body. The main design of the following paper, after finding in several cases the limits of equilibrium, is to trace, if possible, certain unexplained facts to their origin in these primitive relations between the various members of the solar system.

Limits of Planetary Equilibrium.

If two nebulous bodies, M and m, revolve about a common centre of gravity, the disturbing force of M on the superficial stratum of m is the difference between the attraction of the former on the nearest point of the surface of the latter and that on its centre of gravity. The same is true, *mutatis mutandis*, in regard to the disturbing influence of m on M. If, then,

$a =$ the distance between the centres of M and m, and

$x =$ the distance from the centre of the former to the limit of equilibrium of the latter, we shall have

$\frac{M}{a^2} =$ the attraction of M on the centre of gravity of m,

$\frac{M}{x^2} =$ that on the nearest point of the surface, and

$\frac{M}{x^2} - \frac{M}{a^2} =$ the accelerating force of M on the portion of the surface of m between the two centres; but as these forces from M and m are in equilibrium, the neutral point, or the limit of m, may be found from the equation

* Proceedings of the American Philosophical Society, Vol. xviii, p. 324, and Vol. xix, p. 15.

$$\frac{M}{x^2}-\frac{M}{a^2}=\frac{m}{(a-x)^2}-\frac{m}{a^2} \qquad \text{(1).}$$

Applying this equation to the solar system, x will be the equatorial radius, of the solar nebula, and $a - x$ that of a planet at the epoch of its separation. Putting for simplicity $a = 1$, and reducing,

$$x^4 - 2x^3 + \frac{2M}{M-m}\,x = \frac{M}{M-m} \qquad \text{(2).}$$

For Jupiter, $m = 1$ and $M = 1048$, hence

$$x^4 - 2x^3 + 2.0019102x = 1.0009551 \qquad \text{(3),}$$

therefore

$$x = 0.92501,$$
$$1 - x = 0.07499,$$
$$(1 - x) \times 489,000,000 = 35,995,200.$$

Solving equation (2) in like manner for each of the principal planets we obtain the distance from the centre of each to its limit as given in the following table:

Planet.	Dist. to Limit.	
Mercury	152,000	miles.
Venus	700,208	"
Earth	1,082,147	"
Mars	764,650	"
Jupiter	35,995,200	"
Saturn	44,887,000	"
Uranus	48,915,000	"
Neptune	81,000,000	"

In these estimates we neglect the eccentricity of the orbits as well as the centrifugal force due to each planet's rotation. The masses and distances adopted are those given in Newcomb's Popular Astronomy, with the exception that for Mercury we have employed a mean between Von Asten's evaluation of the mass $\left(\frac{1}{7,636,440}\right)$ and the final value given by Leverrier $\left(\frac{1}{5,310,000}\right)$. The mean is $\frac{1}{6,263,800}$. For the earth we have taken the sum of the masses of the earth and the moon.

Applying equation (2) to some of the secondary systems we find the following limits of stability:

For the Moon	39,850	miles.
Phobos	6.5	"
First satellite of Jupiter	5,250	"
Mimas	1,500(?)	"

Practical Applications.

The results obtained may now be employed in the approximate solution of several interesting problems. The limits of stability will be regarded as the primitive radii of the planets and satellites, as any exterior matter would have been detached by the influence of the central body. To the

primitive relations above developed may we not hope to trace some of the unexplained facts of the solar system? As has been remarked by an eminent writer,* "the plan of the coming universe must have resided in the initial chaos, as certainly as the eagle is in the egg, or the leviathan in its primitive germ."

I. To find the relative mean densities of the earth and moon at the epoch of their separation.

With the notation used in equation (1) the ratio sought will evidently be

$$\frac{\rho M}{x^3} : \frac{m}{(a-x)^3},$$

where ρ = the ratio of the equatorial to the polar radius of the terrestrial spheroid. The value of this ratio is not known. An approximate value may be found, however, by a tentative process.

We have $a = 240,300$ miles, $x = 200,450$, $a - x = 39,850$, $M = 81$, and $m = 1$. Hence the ratio is $0.636\rho : 1$.

But during the cooling period the ratio of the densities would probably be nearly constant; or, if the moon contracted more rapidly its solidification would occur earlier and the increase of its density practically cease. The present ratio of the mean densities is 5.67 : 3.57, and assuming this to have been constant we obtain

$$0.636\rho : 1 :: 5.67 : 3.57,$$

or,

$$\rho = 2.498;$$

that is, the ratio of the earth's equatorial to its polar radius at the epoch of the moon's separation was nearly 5 : 2, and this may be regarded with some probability as nearly the ellipticity in other cases at the respective epochs of separation.

II. To find the relative mean densities of Jupiter and his first satellite at the epoch of the latter's origin.

Here $a = 260,000$ miles, $x = 254,750$, $a - x = 5250$; and therefore the ratio is

$$\frac{59240\rho}{(254750)^3} : \frac{1}{(5250)^3} = 0.52\rho : 1,$$

and assuming the constancy of the ratio,

$$0.52\,\rho : 1 :: 121 : 100; \text{ or, } \rho = 2.33.$$

This value of ρ is nearly equal to that found for the earth; the difference being no greater than might result from the probable error in the elements used.

The present density of Phobos is unknown; but with $\rho = 2.5$, the value found for the earth, the ratio of the original densities of Mars and Phobos was 1.27 : 1. These results seem to indicate that the ratio of the equatorial to the polar radius of the central mass, at the epoch of a planet's or satel-

* Prof. Pierce.

lite's origin, was about 2.5.* With this value of ρ, and the value of x already obtained for each planet, the ratio of the mean density of the solar mass to that of the planets at the respective epochs of their separation would have been as follows:

For Neptune	1.31 : 1
" Uranus	1.31 : 1
" Saturn	1.39 : 1
" Jupiter	1.39 : 1
" Mars	1.25 : 1
" Earth	1.29 : 1
" Venus	1.27 : 1
" Mercury	1.22 : 1

From these numbers we infer that central condensation had commenced in the solar nebula before the origin of Neptune, and that the ratio of the mean density to the density of the equatorial parts near the surface was approximately the same at the successive epochs of planetary formation.

Were the Planets formed from nebulous Rings?

If the original solar mass, like most nebulæ, was irregular in form, the first matter detached would not probably be a ring, but a nebulous planet. As condensation advanced, the centrifugal force would increase until approximately equal to the central attraction. The disturbing influence of the planet already formed would produce, when in perihelion, an increasing tidal-wave, resulting in the separation of a second planet. The origin of other planets is accounted for in like manner. If, in the ancient history of the system, nebulous matter, left at first exterior to the orbit of a new planet, should subsequently fall upon the central body, the effect would be not only a shortening of the period, but probably also a lessening of the orbit's eccentricity.

III. *The Peculiar Relations of the Martian System.*—Professor Pickering estimates the diameter of Phobos at seven miles.† Adopting this value, and supposing the ratio between the densities of Phobos and Mars equal to that between the moon and the earth, we shall find the limit of the satellite's equilibrium to be 6.5 miles from its centre, or three miles from its surface. Were the density reduced to that of Saturn, the limit would be almost exactly at the surface; or, with a density equal to that of Mars when the radius of the latter was that of the satellite's orbit, the limit would be at a considerable distance within the surface. Since, therefore, the satellite could never have existed at its

* It was shown by Laplace that a rotating homogeneous fluid cannot retain its spheroidal form when ρ is greater than 2.7197. Mec. Cel. III, *iii*, §20 [1605'], Bowditch's Trans. The ratio would be less in the case of central condensation.

† Annals of the Observatory of Harvard College, Vol. xi. Professor Seth C. Chandler makes the diameter still less. See Sci. Obs. for Sept., 1877.

present distance in a nebular state, it must follow, if any form of the nebular hypothesis is to be accepted, that its original distance was greater than the present. Can we assign a probable cause for this ancient disturbance?

Of the eight major planets, Mars has the most eccentric orbit, except that of Mercury; its perihelion distance being 13,000,000 miles less than its mean distance. This difference, in fact, amounts to 20,000,000 miles when the orbit of Mars has its greatest eccentricity. If, therefore, the radius of the sun, or of the solar atmosphere, was somewhat greater than the least distance of Mars at the commencement of the latter's separate existence, the planet in perihelion would pass through the outermost equatorial zone of the solar nebula. This resisting medium would not only accelerate the motion of Mars, but also, in a much greater degree, that of his extremely small satellites. The solar volume, meanwhile contracting more rapidly than the orbit of Mars, would finally leave the latter moving in an eccentric path, without sensible resistance.*

IV. *The Saturnian System.*—For Mimas, the first satellite of Saturn, the most probable values of the mass and density give the distance of the limit from the satellite's surface less than the radius of Mimas. The rings of Saturn, in all probability, could not exist as three satellites, the limits of equilibrium being interior to the surface. This is true at least in the case of the innermost ring. Analysis seems to indicate that PLANETS AND COMETS HAVE NOT BEEN FORMED FROM RINGS, BUT RINGS FROM PLANETS AND COMETS. If, without any loss of mass, the density of a planet were diminished until the radius should exceed the limit of equilibrium, what change would take place in the planetary form? Evidently a portion of the matter nearest the central body would be separated from the rest, and, as the orbital velocity would be less than that corresponding to its distance, it would move in a new ellipse, the aphelion of which would be the point of separation.

V. *Comets.*—The effect of the sun's attraction in the dismemberment of comets is well known to astronomers. The nuclei of the large comets of 1680, 1843, 1880 and 1882 must have had great force of cohesion between their parts, in order to withstand the tendency to disintegration at the times of perihelion passage. Had the nuclei been either liquid or

* This view was first presented in the Observatory for January, 1878. Different explanations of the short period of Phobos have been proposed by astronomers, but none, perhaps, entirely free from difficulties. One distinguished writer has suggested that $7^h\ 39^m$, the period of Phobos, was the rotation period of Mars at the epoch of the satellite's origin, and that the lengthening of the period to $24^h\ 37^m$ has been due to retardation by solar tides. But it is well known that the time of rotation of a planet in the process of condensation varies as the square of its radius. The resulting period of Mars, therefore, on reaching its present dimensions, would have been but a small fraction over one hour. This period, it is true, would have been somewhat modified by the counteracting influence of the solar tides; but the hypothesis referred to seems wholly inadequate to meet the objection derived from equation (2).

gaseous, or even clusters of solid meteorites, the difference between the sun's attraction on the central and the superficial parts would have pulled the comets asunder, spreading out the fragments into somewhat different orbits, like the meteoric streams of August and November.

This view of the gradual dispersion of comets in perihelion is in striking harmony with the facts of observation. The comets of short period have not only been divested of tails, which in all probability they originally possessed, but they seem to be losing more and more of the cloud-like matter which surrounds their nuclei. Halley's comet has lost much of its ancient splendor, and, had its period been no greater than that of Encke's or Biela's, it might long since have been reduced to a telescopic magnitude. The separation of Biela's comet, in 1845, was not the beginning of that body's dismemberment. We have evidence that this process had commenced before 1798, as in that year a meteoric shower, produced by its *débris*, was observed in Europe. A shower derived from the same group was again seen in 1838.* Before 1845, however, the separated fragments were too small to be individually recognized. How far the sun's action alone can explain the facts, it may be impossible to determine.

VI. *The Zodiacal Light.*—Original small planets near the sun, in a nebular or gaseous condition, would probably be transformed either into rings or meteoric clusters, the scattered particles of which, reflecting the sun's rays, would present an appearance like that of the zodiacal light.

VII. *Origin of the Asteroids.* — In the primitive condition of a planet, immediately after its separation from the central mass, not only would the latter cause a considerable elongation of the former in the direction of the line joining their centres, but the planets also—especially the larger—would produce great tidal elevations on the sun's surface. Now, a comparison of the elements of Hilda and Ismene, the 153d and 190th asteroids, shows them to be an isolated pair whose periods are very nearly equal, each exceeding the longest in the interior cluster by more than fifteen months. Jupiter's limit of equilibrium, when in the nebular form, was immediately beyond the orbits of these minor planets. If the sun once extended to the aphelion distance of Hilda (4.632), the central attraction of his mass on a particle of the equatorial surface was but five times that of Jupiter at the point to which he was vertical.† The centrifugal force due to the sun's rotation would be greatest at the crest of this tidal wave, produced by Jupiter, so that parts might become separated from the solar mass, and transformed into asteroids. It is to be further remarked that two periods of Jupiter are approximately equal to three of Hilda and Ismene, that is, to three rotation periods of the sun at the epoch of their separation. The disturbing effect of the "giant planet" on the tides of the central body would therefore be increased at each perihelion passage.‡

* Humboldt's Cosmos, Bohn's ed., Vol. iv, p. 582.

† Jupiter's perihelion distance is 4.95.

‡ The longitude of Ismene's perihelion differs from that of Hilda's by 180°.

The process would be similar when one period of Jupiter was equal to two rotation periods of the central nebula.

VIII. *The Rotations of the Planets.*—It is well known that the analogy between the periods of rotation of the primary planets, as published by the present writer several years since, assigned a much longer period of rotation to Uranus than to Jupiter or Saturn. But as that of Uranus had not been measured, and the observations of the polar compression were by no means accordant, the fact was not then thought incompatible with the proposed law of rotation. Recent measurements, however, leave no room to doubt that the ellipticity is even greater than that of Jupiter, and consequently that the planet moves rapidly on its axis. The law connecting the rotation periods must accordingly require an important modification.

In a planet having a constant mass, with a variable volume, the time of rotation varies as the square of the radius. It is easy to show, however, that this law could not have obtained from the origin of the solar system. For instance, in tracing backward the history of the earth, we find that when the radius was 8000 miles, its rotation period, according to this law, was 96 hours; when the former was 12,000 miles, the latter was 216 hours; and, finally, if the earth ever extended to the moon's orbit, the time of rotation, by the same law, instead of having been equal to the moon's orbital period, was nearly ten years. So likewise when Mars filled the orbit of Phobos, his rotation period was 7 days and 16 hours, or 24 times the orbital period of the satellite. We conclude, therefore, that during the earlier stages of its condensation all parts of the mass did not rotate in the same time. It is easy to see, in fact, that tidal retardation must have been much more effective at the surface than in the interior of a large planet in the gaseous state.

In so far as we know, the rotation period of the smaller planets, Mercury, Venus, the Earth and Mars, are nearly two and a half times those of the larger and more remote. What cause can be assigned for this remarkable difference? In other words, why did the process of condensation continue longer in the large and less dense planets exterior to the asteroids than in the small bodies nearer the sun? It may be answered in a general way that in small and dense planets solidification would occur at a comparatively early epoch in their history, and hence the acceleration of their rotary velocity would be, in a large measure, arrested. It seems probable, therefore, that, while the same law of rotation may obtain between the members of each separate group, it cannot apply where one of the planets is in the inner and the other in the outer cluster.

As regards their axial movements, the solar system appears to contain at least three distinct classes of planetary bodies; the obvious characteristics of each being traceable to their relative primitive densities. These are as follows, the primitive density of Neptune being taken as unity:

I The large planets :

	Primitive Density.
Neptune	1.0000
Uranus	3.8950
Saturn	32.7073
Jupiter	210.7440

II. The planets interior to the zone of asteroids :

Mars	7,446.4
Earth	24,880.5
Venus	70,129.2
Mercury	468,616.0

III. The secondary planets, of which our moon and Jupiter's first satellite may be taken as types :

Jupiter's first satellite	2,600,000
The Moon	4,820,000

There is, we may remark, an antecedent probability that the law truly formulated will assign to Saturn a period of rotation somewhat less than the period observed ; as it is sufficiently obvious that if the ring had remained an integral part of the planet, the resulting time of rotation would have been, in fact, sensibly shorter than the present. It is also to be remembered that the late observations of Denning and Schiaparelli make Mercury's time of rotation nearly 25 hours. In the case of the satellites, the equality between the periods of rotation and revolution was established at an early epoch in their history. No further decrease in the time of rotation was therefore possible.

A comparison of the quantities used in equation (1) suggests that a planet's time of rotation is a function of its mass, distance, and primitive density. The form of this function—found by a tentative process—may be expressed as follows :

The square of the number of a planet's days in its year is to that of any other of the same group, as the primitive density of the latter is to that of the former ; that is,

$$n^2 : n' :: \triangle' : \triangle \text{; or, } n' = n \left(\frac{\triangle}{\triangle'}\right)^{\frac{1}{2}} \quad \ldots\ldots (4),$$

where

$$\triangle = \frac{m}{\mathrm{R}^3} = \text{the primitive density, and}$$

$$n = \frac{T}{t} = \frac{\text{orbital period}}{\text{rotation period}} = \text{the number of a planet's days in its year.}$$

Equation (4) may be reduced to

$$t^2 : t'^2 :: m \left(\frac{d}{R}\right)^3 : m' \left(\frac{d'}{\mathrm{R}'}\right)^3 \quad \ldots\ldots (5),$$

where d, d' and R, R$'$ are the respective distances and primitive radii.

The Outer or less dense Group.

In the following table the rotation periods of Saturn, Uranus and Neptune are derived from that of Jupiter by formula (4).

Planet.	m	R	$\triangle$	T	t	n
Neptune.	16.86	81,000,000 m	1.0000	60,126.71 d	9 h 35 m	150,751.80
Uranus..	14.46	48,915,000	3.8950	30,686.82	9 33	77,186.00
Saturn...	93.84	44,887,000	32.7073	10,759.219	9 43	26,630.00
Jupiter..	311.80	35,995,200	210.7440	4,332.584	9 55	10,492.64

It will be noticed that the theoretical period of Saturn is 31 minutes less than Hall's evaluation.

The Inner Group.

Planet.	m	R	$\triangle$	T	t (h m s)	n
Mars....	0.1056	764,650 m	7,446.40	686.98 d	24 37 23	669.57
Earth....	1.0000	1,082,147	24,880.5	365.26	23 53 48	366.84
Venus...	0.7690	700,208	70,129.2	224.70	24 42 54	218.18
Mercury.	0.0522	152,000	468,616.0	87.97	25 0 46	84.405

Here the rotation periods of the earth, Venus and Mercury are derived from that of Mars by formula (4). The first is two minutes less than the true period; the time of Venus's rotation is doubtful; and the theoretical determination of Mercury's period agrees with the estimate of Mr. Denning.

Notes on the Geological Structure of Tazewell, Russell, Wise, Smyth and Washington Counties of Virginia. By John J. Stevenson, Professor of Geology in the University of the City of New York.

(Read before the American Philosophical Society, November 21, 1884.)

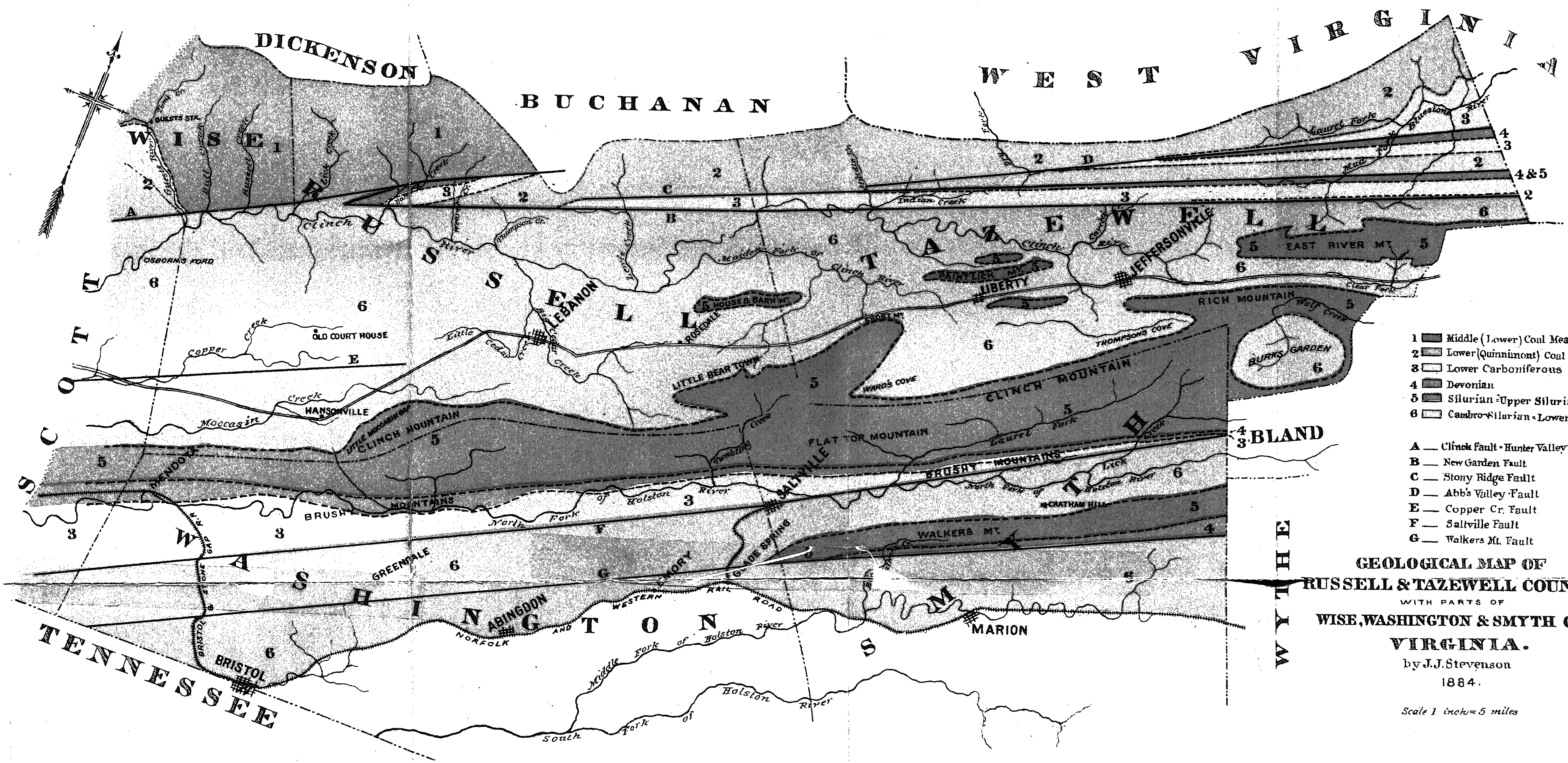
INTRODUCTION.

This memoir is practically a continuation of the writer's memoirs on southwestern Virginia, read before this Society in August, 1880, and in January, 1881. In it the description is carried eastward so as to connect with the reconnaissance work described in the writer's memoir, read in October, 1881. This, however, differs from those in that it contains no references to economic geology except in so far as may be needful to the explanation of structure.

Little has been published respecting the geology of this region, the only memoir of material importance being that by Prof. J. P. Lesley, read before this Society in 1871.* The writer is indebted to this for some useful information, which will be acknowledged fully in its proper place. A note in *Science* by Mr. E. G. Squier, makes one wish that that observer had published more of his work. Brief notices of the Saltville basin and vicinity have been published by Profs. W. M. Fontaine and C. H. Hitchcock, but these give little of detail.

Like the region described in the writer's previous memoirs, this shows no monotony of surface. The Great valley of Virginia, with its floor of Cambro-Silurian rocks, occupies a great part of Washington and Smyth counties, and has as its north westerly boundary the irregular Walker mountain. That mountain is a low ridge of limestone in Washington county, but in Smyth county it becomes double, consisting of a Medina ridge, Big Walker, separated by a Clinton valley from the Devonian ridge, Little Walker, which overlooks the valley. Rich valley separates Big Walker mountain from Brushy mountain, a ridge of Devonian and Lower Carboniferous, which is separated by a narrow and somewhat indefinite Poor valley from Clinch mountain, these two ridges bearing the same relation as Big and Little Walker. There is then a succession of "Poor" and "Rich" valleys; the latter, with limestone soils, are either

*Lesley. The Geological Structure of Tazewell, Russell and Wise Counties in Virginia. Read April 21, 1871.



1 Middle (Lower) Coal Measures
2 Lower (Quinnimont) Coal Measures
3 Lower Carboniferous
4 Devonian
5 Silurian - Upper Silurian
6 Cambro-Silurian - Lower Silurian

A — Clinch Fault - Hunter Valley Fault
B — New Garden Fault
C — Stony Ridge Fault
D — Abb's Valley Fault
E — Copper Cr. Fault
F — Saltville Fault
G — Walkers Mt. Fault

GEOLOGICAL MAP OF RUSSELL & TAZEWELL COUNTIES

WITH PARTS OF

WISE, WASHINGTON & SMYTH COS,

VIRGINIA.

by J. J. Stevenson

1884.

Scale 1 inch = 5 miles

Lower Carboniferous or Cambro-Silurian, while the former are either Silurian or Devonian. *The* Poor valley is that which follows the southerly foot of Clinch mountain from far beyond the Tennessee line north-eastward into Bland county. *The* Rich valley is that which lies along the northerly foot of Walker mountain, rudely following the Saltville fault to just beyond Saltville

The region between Clinch mountain and Clinch river shows many broad "bottoms," and much handsomely rolling land. The immediately underlying rocks are Trenton and Knox in most of the region, but toward the eastern end strips of Hudson and Medina are held in narrow synclinals, and form short ridges which are striking features of the scenery. *Two limestone ridges. Copper and Moccasin, are persistent.*

The whole area is fairly well watered, though in those parts directly underlaid by limestone springs are apt to be uncertain, as the waters frequently disappear through newly made crevices in roofs of caverns, where they join underground streams, which occasionally break forth with enormous volume. The principal water ways are the Clinch and the two forks of the Holston. The Clinch, rising in eastern Tazewell, drains nearly the whole of that county and Russell with much of Wise Its important tributaries from the south are the Maiden Spring fork in Tazewell and Copper creek, which, rising in Russell, enters the river in Scott county. The tributaries from the north are numerous, but, with the exception of Guest's river in Wise county, they are very short. Bluestone river and Wolf creek, draining the eastern part of Tazewell, flow to the New river The North fork of the Holston river rises in Bland county not far east from the Smyth county line and drains the space between Walker and Clinch mountains, with a narrow strip north from Clinch mountain in Scott and Russell counties The South fork of Holston drains the Great Valley The Clinch and Holston unite in Tennessee to form the Tennessee river

Only the southern part of the area under consideration has railroad facilities The Norfolk and Western Railway follows the valley; its New River branch, passing through Pulaski and Giles counties of Virginia and Mercer county of West Virginia, reaches the extreme north-east corner of Tazewell county at the Pocahontas mines, its Saltville branch extends from Glade Spring to Saltville. A railroad to extend from Bristol to the Big Stone gap in Wise county has been graded from Bristol to Mendota, about sixteen miles, but no work has been done on it for some time. Clinch mountain makes very difficult access from the valley to the region beyond, for, in its whole length of more than 100 miles from the Tennessee line to the eastern edge of Bland county, there is but one water gap, and only one wind gap which affords easy grades for a wagon road. The former, Big Moccasin, has been taken for the Bristol and Stone Gap road, and the other, Little Moccasin, has been occupied by a survey for the Norfolk and Cincinnati Railway Company. This is a difficult pass for railway operations, but Mr. Oramel Barrett, Jr., has succeeded in locating

an available line through it. Some conception of the difficulties to be overcome by a road in passing from the valley to Clinch river may be had, when one remembers that in that interval the line must cross Walker mountain, Rich valley, Brushy mountain, Poor valley, Clinch mountain, and the irregular limestone ridges of Tazewell county. Roads have been projected and survey lines run across the headwaters of streams entering Clinch river from the north, having for object the passage into Kentucky. None of these has advanced beyond the preliminary surveys.

Several wagon-roads with good grades were constructed many years ago by State aid, and some excellent pikes were constructed by private companies. The engineering of the Tazewell pike and of the Hayter's Gap road as they cross the abrupt Clinch mountain is remarkably good. The grades of the Fincastle pike passing through the county seats of Tazewell, Russell, Scott and Lee on the way to Cumberland gap are very easy. The common roads, as in too many other parts of our country, are far from being good; often a very fair wagon road terminates suddenly in a mere trail with almost impassible grades. The traveler finds horseback the more comfortable as well as the more expeditious mode of conveyance.

The especial industries of the region are grazing and tobacco culture. The limestone soils yield grass equal to that of Kentucky, and beef cattle from the ridge land of Russell and Tazewell are thought to be equal to those from any other region of our country. The timber is superb, walnut, poplar, oak, ash and hickory being still plentiful beyond Clinch river. The mineral resources are important. Brown hematites occur at many localities, fossil ore is present in greater or less quantities on Big Walker, Clinch, Paint Lick, Rich and East River mountains; oxide of manganese was seen on Rich mountain and Copper ridge, barium sulphate is present at times in considerable quantity; the Estilville marbles are of the finest quality and in almost unlimited quantity; salt and gypsum of great excellence are found in the valley of the North Holston, north from the Clinch river is the great coal field, containing in Tazewell and part of Russell the soft coking coals of the Quinnimont group or Lower Coal measures, while in western Russell and in Wise county, north from Stone mountain, are the harder coals, the shipping coals of the Middle Coal measures. For the present, however, none of all these resources, agricultural and mineral, is available, except that of converting grass and grain into beef, the cost of transportation destroying the value of the rest.

The following lists of altitudes have been supplied to me by the gentlemen whose names precede the lists:

Altitudes on and near the Line of the Norfolk and Cincinnati Railroad From Oramel Barrett, Jr., Chief Engineer.

Elevations above mean tide at Norfolk, Virginia, all taken with the level, except a few by barometer which are specially indicated.

Washington County.

Abingdon station, sub-ballast on N. and W R. R. ... 2056 8

Walker Mountain summit, on turnpike from Abingdon to Liberty	2145
Low water, N. F. of Holston, mouth of Little Moccasin creek, barometer	1430
Same at mouth of Wolf creek, below Saltville	1508
Little Moccasin gap, summit on line between Washington and Russell counties	2377
Clinch Mountain summit, one mile N. E. of Little Moccasin gap, by triangulation; is about average altitude of the crest for nine miles north-east to near Hayter's gap	4244
Clinch Mountain summit (Rich mountain), at head of Stuart run	3264
Hayter's gap in Clinch mountain	3025

Russell County.

Divide between Big Moccasin and Little Cedar creeks, close to Abingdon and Lebanon pike	2341
Little Cedar creek just below Mr. Brown's milldam, three miles south from Lebanon	2090
Dickersonville, in front yard of dwelling between house and store	2043
Summit of Copper ridge near Wise C H, road at head of Copper and Ocean Cove creeks	2288
Fincastle pike, eastern base of Copper ridge, one mile and a half N E. from Dale Carter place	2075
Summit of Copper ridge in public road at head of Jesse or Mill branch	2226
Springs at head of Jesse branch	2025
Surface of low water in Clinch river at mouth of Dump creek	1480.5
Grissell coal bed on Dump creek	1720
Eastern base of Sandy ridge at head of Hurricane fork of Dump creek	2000
Gap in Sandy ridge at head of Hurricane fork of Dump creek, and Caney fork of Indian creek, the latter flowing into Russell fork of Big Sandy river	2302
Sandy ridge, approximate average elevation of, for several miles east and west from the above-mentioned gap	2600
High knob on Sandy ridge, back of ex-Sheriff James Kiser's house, at head of Dump and McClure creeks, barometer	3100
Bower's gap in Sandy ridge at head of Weaver and Indian creeks	2300
Little Cedar creek in front of Lebanon	1970

Surface water in mill-dam, Big Cedar creek at Elk Garden. 2120
In public road in front of residence of Mr. W. A. Stuart, on Big Cedar creek.......................... 2170
War gap, in spur of Clinch mountain, drained by branch of Big Cedar creek. 2500
In meadow, front of Rosedale store, looking toward Big Cedar creek. 2330
Front of E R. Baylor's store, on divide between Big Cedar creek and North fork of Indian creek of Maiden Spring fork................................ 2448
Clinch river at mouth of Lick creek 1404.5
Same at mouth of Jim Jack creek, above Lick creek.. 1408

Dickenson County.

Surface of low water in Russell fork of Big Sandy river at mouth of Indian creek.................... 1415
Same at mouth of Frying Pan creek................ 1206.6
Same at mouth of McClure creek. 1240 5
Same at the mouth of Pound fork.................. 1170
Same in the "Breaks" at the base of the highest "tower," two and three-fourths miles from the Kentucky line. 1060
Same at Kentucky line by barometer. 850

Wise County.

Summit of Whetstone Mt, 200 feet north from Wise Court House road, between Russell and Whetstone creeks.. 1843
Surface of water in Russell creek, one-fourth mile below R. Dickenson's house, directly below mouth of Little Russell creek............................. 1530
Summit of Bull hill, between Russell and Bull creeks, close to Wise Court-House road................... 1910
Surface of water at junction of Little and Big Bull creeks.. 1425
Summit between Dry fork of Bull creek and Crab Orchard creek..... 2097

Elevations in Southwest Virginia, by South Atlantic and Ohio Railroad levels, reduced to tidal elevations, taking Bristol, Tenn., on Norfolk and Western Railroad, at 1670 feet above tide. John C. Oliphant, Superintendent and Engineer.*

Washington County.

Bristol....................... 1670
Summit of Walker mountain. 2077
N. F. Holston river at Mendota 1325

* In the body of this memoir, this road is referred to as the Bristol and Stone Gap R R.

Scott County

Moccasin gap in Clinch mountain	1233
Summit at Troublesome creek	1565
Clinch river at Spear's ferry	1185
Flat Lick summit	1540
Slemp's gap, end of Powell mountain	1320

Wise County.

Wild Cat summit	1905
Mineral city	1550
Big Stone gap	1555
Divide between Powell and Guest's rivers	2160
Guest river, near Lost creek	2090

Dickenson County.

Divide between Guest's and Pound rivers, at head of Indian creek	2605
Mouth of Indian creek of Pound river	1513
Big Sandy river at Kentucky line	854

I. THE GENERAL STRUCTURE.

As is already familiar to those who have read Prof. Lesley's memoir of April, 1871, or that of January, 1881, by the writer, the especial interest attaching to Southwest Virginia lies in the great faults or cracked anticlinals which have so great extent both longitudinally and vertically. So far as known to the writer, the existence of these faults was first indicated by Prof. W. B. Rogers in his earliest report on the geology of Virginia,* three principal faults being shown on the long cross-section. The existence of the Saltville and New Garden faults is asserted in a paper on Thermal Springs by the same author and in a long memoir on the structure of the Appalachian Chain by Profs W. B and H. D. Rogers † Some of these faults are very simple in structure, but others are sufficiently complex. Groups of anticlinals occur, canoe-shaped and overlapping, thus reproducing the features so characteristic of Silurian and Cambro-Silurian areas of Central Pennsylvania.

The structure may be considered most conveniently by going from the Great Valley northward to the Coal Measures area, taking the more prominent features in order as follows :

The Fault of Walker mountain
The Saltville fault.
The Clinch Mountain group of folds.

* W. B. Rogers. Report of the Geological Reconnaissance of the State of Virginia. 1836.

† These papers are contained in the volume of Transactions of the Association of American Geologists and Naturalists. 1840–42.

The Copper Ridge fault and the Elk Garden anticlinal.
The House and Barn synclinal.
The Clinch River system of faults.
The Stone Mountain anticlinal.

The Fault of Walker Mountain.

The Great Valley of Virginia extends in Washington and Smyth counties from Walker mountain south-eastwardly to the limit of those counties. It is underlaid by Cambro-Silurian rocks whose calcareous beds have yielded readily to erosion. The dip is undulating, and one well-marked anticlinal is crossed frequently by the turnpike between Seven-mile ford and Bristol.

The fault of Walker mountain is clearly the same with that which is termed the *South Fork of Holston Upthrow* on Prof. Lesley's map of 1871. As, however, it nowhere approaches the South fork of Holston, the writer prefers to retain the name applied to it in his memoir of 1881 It is wrongly placed on the map accompanying that memoir, though its position is given rightly in the text as at about four miles from Bristol. The error arose from a misunderstanding respecting the true place of Walker mountain, so that on that map, this fault occupies very nearly the place of the Saltville fault.

This fault, in much of Washington county, brings the Trenton limestone into contact with the lower part of the Knox group. Where it is crossed between Bristol and Mendota cannot be determined accurately without detailed study, but the course is shown approximately by a rather low ragged ridge of limestone which can be followed without difficulty to the eastern edge of Washington county. The line of fault is crossed by the Saltville branch of the Norfolk and Western Railroad at the water station, somewhat less than two miles from Glade spring. Thence the downthrow rapidly increases, and within two miles the ragged ridge of limestone becomes Walker mountain with Medina and Clinton, the fault line passing just north from Washington springs. The downthrow continues to deepen, Devonian is held on the northerly side of the fault, and the mountain is divided into Big and Little Walker, Medina and Chemung ridges, separated by a valley of Clinton and Hamilton. This structure is well shown on Chilhowie creek, though at the place of the fault, nearly three miles north from the railroad, everything is wholly concealed. It is altogether probable that the lowest beds of the Lower Carboniferous are held on the north side of the fault toward the eastern edge of Smyth county, for in the adjoining county of Wythe Vespertine coal beds occur and they have been worked. Unfortunately one cannot determine with equal ease the changes which take place on the southerly or upthrow side of the fault; the Knox limestones have yielded to erosion and solution and for the most part their surface is deeply buried under débris. There is no room for doubt, however, that

the cherty beds of the Knox, which weather with a fretted surface, are exposed along the southerly side as far eastward as the Saltville railroad

Northward from the fault of Walker mountain the sequence is regular until, at a distance of about four miles, the

Saltville Fault

is reached. This was designated in the writer's previous memoir as the fault of the *North Fork of Holston,* the name applied to it by Prof. Lesley. That observer having touched this fault only near Saltville, naturally applied to it the name of the river by which it is crossed more than once in that neighborhood. But, as will be shown, that name is misleading, and "Saltville" is much preferable, as the line of the fault passes through the widely known village of that name.

This fault is crossed by the Bristol and Stone Gap Railroad grade within a few rods north from the Rich Valley road and only a little way south from the deep cut on Wolf Run summit Its place is wrongly indicated on the writer's earlier map, on which it should be very nearly where the Walker Mountain fault has been placed The course of the fault eastward from the railroad is almost straight to Saltville on the border of Smyth county It passes through that village not many yards from the salt shaft: it lies between the Broadford road and the river, is crossed by the latter probably twice within six miles east from Saltville, and is again crossed or touched by it at ten miles from Saltville; it is crossed by Cove creek at a little way north from I. H. Buchanan's house and by Lick creek at only a little way north from the Saltville and Sharon Springs road. Beyond ten miles eastward from Saltville, that road lies south from the fault.

The North fork of Holston rises in Bland county, follows a very serpentine course through Knox and Trenton limestones for fifteen or twenty miles, and touches the Saltville fault at ten miles east from Saltville. Thence until very near the Broadford, six miles from Saltville, the river is south from the fault, but in the next three miles the fault is crossed certainly more than once. At somewhat more than three miles east from Saltville the river crosses to the northerly side of the fault, finally. Within Washington and Scott counties the river bed and the fault are from two to five miles apart, with the clumsy Brushy mountain occupying the interval. In a distance of seventy or eighty miles the North fork of Holston crosses or touches the Saltville fault not more than four times, all of them within a space of eight miles, while during the rest of its flow through Bland, Smyth, Washington and Scott counties it is from one to five miles either north or south from the line of fracture. Its course seems to be dependent on neither the fault nor the character of the rocks for it is serpentine alike through the yielding limestones of the Trenton, the refractory sandstones of the Knox, the hard and soft limestones of the Lower Carboniferous, the soft shales and hard sandstones of the Lower Carboniferous, Devonian and Silurian.

The relation of the Saltville fault to the Burk's Garden anticlinal of the

I.

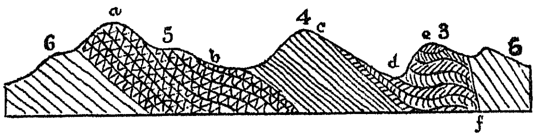


FIG. I.—From Moccasin creek to the Saltville fault beyond Wolf Run summit. *a*, Clinch Mt. *b* Poor valley. *c*, Brushy Mt. *d*, N. F. of Holston river. *e*, Wolf Run summit. *f*, Saltville fault. 3, Lower Carboniferous. 4, Devonian. 5, Silurian. 6, Cambro-Silurian.

II.

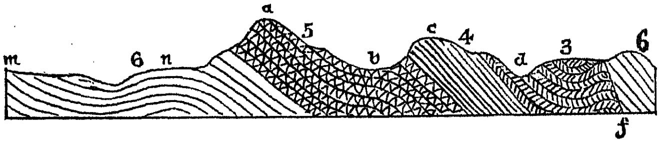


FIG. II.—From Fincastle pike to the Saltville fault through Hayter's gap. *a*, Clinch Mt. *b*, Poor valley. *c*, Brushy Mt. *d*, N. F. of Holston river. *f*, Saltville fault. *m*, southerly slope of Elk Garden anticlinal. *n*, Loop anticlinal. Numbers as in Fig. 1.

III.

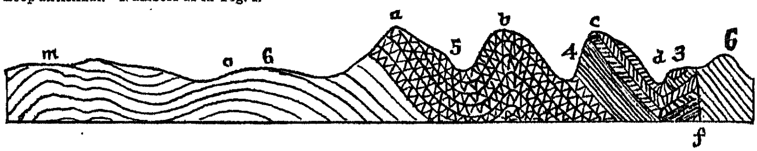


FIG. III.—From Fincastle pike at Liberty to the Saltville fault at nine miles west from Saltville. *a*, Clinch Mt. *b*. Flat Top Mt. Burk's Garden anticlinal. *c*, Brushy Mt. *d*, N. F. Holston river. *f*, Saltville fault. *m*, Elk Garden anticlinal. *o*, Cove anticlinal. Numbers as in Fig. 1.

IV.

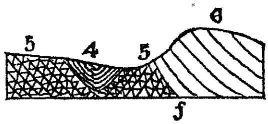


FIG. IV.—Apparent structure of Clinch fault at gap of North fork of Clinch river, through Buckner's ridge. *f*, Fault. Numbers as in Fig. I.

V.

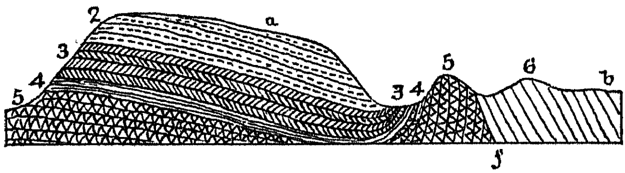


FIG. V.—Cross-section along Stony creek, through Powell mountain and Buckner's ridge. *a*, Powell-Stone Mt. *b*, Buckner's ridge. *f*, Clinch fault. 2, Lower Coal Measures, Quinnimont. Other numbers as in Fig. I.

VI.

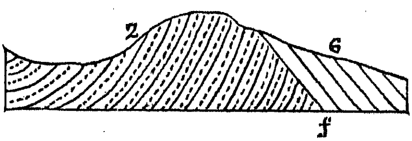


FIG. VI.—Clinch fault on Osborn Ford road. *f*, Fault. Numbers as before.

VII.

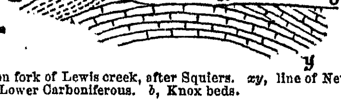


FIG. VII.—Structure on Robinson fork of Lewis creek, after Squiers. *xy*, line of New Garden fault. *a*, Lower Coal measures (Quinnimont). *E*, Lower Carboniferous. *b*, Knox beds.

Clinch Mountain group of folds is of no little interest as having some bearing on the relative age of the folds and faults. The anticlinal originates probably at but a little way from Little Moccasin creek, and as it increases steadily eastward, it thrusts the outcrops of the successive groups further and further toward the south-south-east. On Wolf run, along the railroad grade, the whole of the Lower Carboniferous column is exposed, the red shales being well shown in the long cut at the summit. These rocks describe a synclinal and anticlinal which are distinct on Wolf run. On this railroad line, then, the Knox beds are in contact with the very top of the Lower Carboniferous. Eastward the red shales are cut off more and more in the fault, so that at Saltville only a small part remains exposed, and the fault passes very near the crest of the anticlinal seen on Wolf run. At ten miles east from Saltville, the greater part of the limestones have been swallowed up, while on I. H. Buchanan's property, sixteen miles from Saltville, there remain merely the clayey limestones and the shales at the base of the series, and at the line of Bland county all has disappeared save the coal-bearing shales.

So this fault, in crossing the strike of the rocks, carries down in succession the several divisions of the Lower Carboniferous. Its course can be followed by the eye without difficulty, for the ragged hills of Knox sandstones and limestones, near whose northerly foot it passes, go directly to Garden mountain, the southerly slope of the Burk's Garden anticlinal. It is wholly probable that, beyond the eastern border of Smyth county, the Lower Carboniferous disappears, so as to bring the Chemung and Knox into contact, while still further east the Lower Carboniferous may re-appear as the anticlinal loses strength.

What erosive effects have been due to the influence of the fault cannot hardly be ascertained. Unquestionably there is what is termed a valley in the vicinity of the fault for much of the distance within Washington and Smyth counties—but it is in the vicinity only; such a valley can be found in the vicinity of almost any other line which one may choose to draw within the limestone region. Rich valley, now on one side, now on the other side of the fault in Washington county, is merely a succession of cross-valleys separated by irregular divides; but in Smyth county it is altogether south from the fault, except near Saltville, and is separated from it by the rugged ridge of Knox beds.

The Clinch Mountain Series of Folds.

This series enters the State from Tennessee at ten or twelve miles west from the line of Washington county, and extends thence in an E.N E. direction through Scott, Washington, Smyth and Bland counties into Giles. Clinch mountain is the bold ridge at the north with a Medina cliff for its crest, with Clinton for its southerly slope and with Hudson and Trenton forming the northerly slope; a Poor valley of Clinton and Hamilton separates it from Brushy mountain, a clumsy mass near the State line, but owing to encroachments by the Saltville fault becoming simpler

and better marked until it is a single ridge with a cliff of Chemung sandstone for its crest.

In a section extending from Moccasin creek to the Saltville fault at Wolf Run summit this series shows monoclinal structure from Moccasin creek until within about two miles of the summit, where one crosses the petty folds already mentioned. At not far from twelve miles further east, near Little Moccasin creek, a new feature is introduced and the Poor valley is divided by a gentle anticlinal, the structure being as represented in Fig. 1. This anticlinal may be the same with that which is designated the Burk's Garden anticlinal, or it may be a petty fold dying out on the Tazewell pike in the synclinal north from that anticlinal The development of the anticlinal and the accompanying synclinal on the northerly side pushes the Clinch outcrop of Medina northward so as to form the irregular Brumley mountain, which at ten or twelve miles further eastward is cut off by the growing Loop anticlinal. The Clinton shales held up by the new anticlinal, widen Poor valley into Brumley and Hayter coves extending from Little Moccasin creek eastward almost to Tumbling creek, somewhat more than fifteen miles in a direct line.

A projection somewhat like Brumley mountain, but better defined, is shown further east beyond the Cedar Creek loop or cove, the first of the coves or anticlinal valleys with Medina rim. Brumley mountain forms the south-westerly boundary, Little Bear town the easterly and northerly, while the notched border of Clinch mountain forms the southerly and south-easterly border. The cove is not wholly enclosed, as the Medina has been removed from the north and north-west for probably five miles. The structure along a section beginning at the Fincastle pike and passing through Hayter's gap in Clinch mountain to the Saltville fault is shown in Fig. 2 The Loop anticlinal is crossed by the road to Hayter's gap just north from the Rich Mountain road. It is complex and apparently attains its maximum further west, where it cuts off the Medina of Brumley mountain. It diminishes quickly eastward so that the Medina outcrops of both Clinch and Little Bear town unite at the head of the cove or loop. The Burk's Garden anticlinal in Poor valley attains to no material elevation along this line, and is simply a broad roll, which serves to carry the outcrop lines of Devonian and Lower Carboniferous southward, as is well shown at Saltville, where nearly the whole of the Lower Carboniferous red shales have disappeared in the fault, which there passes very near the crest of the Wolf Run anticlinal.

The next section, that passing from Liberty on the Fincastle pike to the Saltville fault about nine miles west from Saltville, is shown approximately in Fig. 3. The Thompson-Ward cove, also on the northerly side of Clinch mountain, is crossed by the Tazewell pike along the line of this section. It is not far from twenty miles long and is enclosed on all sides by Medina, save on the north-west, where there is a gap of nearly six miles. The westerly end is known as Ward's cove, enclosed by Short mountain on the north west and on the south by Clinch mountain, which is continuous

along the southerly side of the whole cove The east end, known as Thompson's cove, has Clinch mountain as its southerly boundary and Rich mountain as the northerly. This is a typical cove; the Medina outcrops approach very gradually at each end so as to give a distinctly lozenge-shape to the outline. The Medina has been removed by erosion for a distance of fully six miles, the distance between Short mountain and Morris knob, the latter being the end of Rich mountain; while Plum creek has made a water gap through Rich mountain almost due south from Jeffersonville, the county seat of Tazewell county. There evidently the whole of the Medina has been removed for a distance of nearly three miles—but the ridge is persistent on both sides nearly to the gap The Cove anticlinal is not the same with the Loop anticlinal; as the latter diminishes, the former, lying somewhat further north, increases.

The synclinal between the Cove and the Burk's Garden anticlinal is very close and complex along the Tazewell pike; the dips are abrupt, and three subordinate folds were seen in the Clinton, between Clinch and Flat Top mountains The pike crosses Clinch mountain at but a little way west from the maximum of the Cove anticlinal, crosses the northerly division of the Poor valley, and ascends the Burk's Garden fold which, within six miles, has brought up Medina through the Clinton to form a bold ridge, known as Flat Top or Poor Valley mountain. The Saltville fault is reached beyond Brushy mountain, but the exposures do not suffice for determining how much of the Lower Carboniferous has been cut off.

From this line eastward, the structure of the belt between the Elk Garden anticlinal at the north and the Saltville fault at the south becomes simpler. As the Cove anticlinal diminishes, the synclinals on each side gradually approach until they unite in the valley of Wolf creek, between Rich mountain and Garden mountain. The Medina outcrop of Clinch mountain passes round the easterly end of the Thompson-Ward cove, and forms the crest of Rich mountain eastward from Plum creek, while the Clinton of the northerly Poor valley is continuous with that of the Wolf Creek valley. That the Cove anticlinal wholly disappears before the road leading from Jeffersonville to Burk's Garden is reached is not altogether certain. In descending the southerly slope of Rich mountain along that road, one leaves the Medina at the summit, and quickly comes upon exposures of the Clinton, the dip being almost east of south; but the dip is reversed soon, and the synclinal is close. Exposures in the Wolf Creek valley are not detailed, but the presence of a very gentle anticlinal explains the greatly diminished dip shown an the slope of Garden mountain. The rapid increase of the Burk's Garden axis is shown by the clumsy mass known as Bear town, from which the Medina walls of the Garden pass out. These walls unite at the east end of the Garden to form Round mountain, and thence the fold diminishes. Prof. W. B. Rogers, in one of his memoirs, speaks of this as the "great Garden anticlinal." Burk's Garden has an extreme length of about six miles, and an extreme width of not far from four miles. The surrounding wall is broken only at the

gap of Wolf creek at the north, by which the road from Jeffersonville enters The immediately underlying rocks of the enclosure are Trenton, while Hudson and Medina are shown in the Garden mountain.

The Copper Creek Fault and the Elk Garden Anticlinal.

The Copper Creek fault of the writer's previous memoir was observed in Russell county on the Abingdon and Wise Court-House pike, at a little way from the summit between Tarr's fork of Moccasin creek and a petty branch of Copper creek. The fault is clear because of repetition of the section, and its place is indicated by abrupt steepening of the dip. The line was not followed eastward from that locality, but the fault certainly disappears before Little Cedar creek has been reached, ten miles further east, for there it is represented by two close anticlinals, or by an anticlinal with channeled crest In the Elk Garden, three miles east from Lebanon, this anticlinal is crossed by the Fincastle pike, near Mrs. Smith's house, where it brings up the ferriferous beds at the top of the Knox group; it is distinct as a triple-crested fold passing just south from Liberty in Tazewell county. It passes near Jeffersonville in the same county, and is crossed by the pike at the school-house, about four miles east from Jeffersonville. The course of this axis varies somewhat under the influence of the Loop and Cove anticlinals, so that beyond Jeffersonville it is little more than north of east. This fold is interesting only in that it illustrates the disappearance of a fault in an anticlinal. The Trenton and Knox alone cross it, all newer beds having been removed by erosion.

The House and Barn Synclinal.

This trough lies directly northward from the Elk Garden anticlinal, and appears to be practically co-extensive with it. Some indefinite flexures of Trenton and Knox beds were seen in Scott county, very near the line which this synclinal, if continuous, would follow, but the first real trace is found in Russell county, between the Wise Court-House road and Old Russell court-house, on the way to Osborn's ford. It is thoroughly distinct at six miles further eastward, where the Mill creek and Abingdon roads unite at Little Cedar creek, about two miles west from Lebanon, where it holds the upper or clayey limestones of the Trenton. It passes immediately north from Lebanon, and is distinct on Little Cedar creek, near the road leading to Nash's ford. At both localities it is shallow and double, but its rapid deepening eastward is shown on the road leading from Black's ford to Rosedale, while immediately east from that road it holds a narrow ridge, House and Barn mountain, which carries a slender crest of Medina. This mountain, lying at about a mile and a half north from the Fincastle pike, is cut off by the Maiden Fork of Clinch river; but, within two miles beyond that stream, the Medina ridge again begins, now under the name of Paint Lick mountain, and continues for nearly twelve miles, when it is cut off by Plum creek, a tributary to Clinch river. Paint Lick is no doubt a double synclinal even at its western extremity, but this was not

determined by actual examination. Be that as it may, the mountain is quickly divided into two very narrow synclinals, separated by a narrow, compressed anticlinal, along which a valley has been eroded to the Trenton. The ridge in the southerly synclinal retains the name Paint Lick, while the short irregular ridge in the other trough is known as Deskins mountain, and continues for but three or four miles.

Erosion has been performed so faithfully beyond Plum creek that, for a distance of fully eight miles, all rocks newer than Trenton have been removed from the synclinal, but, at say four miles east from Jeffersonville, the Medina ridge is reached again in East River mountain, which clearly represents Paint Lick It, however, is distinctly double, two synclinals separated by a narrow anticlinal, which evidently widens eastward, so that the synclinal mountains are wholly separate and bear distinct names Deskins mountain appears to be represented by Dial mountain, an irregular little mountain with Medina crest. No examinations were made east from the Dial or north from East River mountain, so that the coloring of that portion of the map is not exact

Within Tazewell and eastern Russell, the rocks rise regularly or nearly so from the synclinal to the New Garden fault, the rate of dip increasing toward the fault; but westward, as the synclinal becomes less pronounced, the rocks become distorted at a distance of two or three miles from the line of fracture. A synclinal occurs on the high limestone ridge, known as Copper ridge, within Scott county, but it disappears before reaching Mill creek in Russell county, for there no traces of it were found. Even where this indefinite synclinal exists, the rocks are badly twisted at varying distances from the line of displacement Thus, on the road to Osborn's ford, the distortion begins at some distance above Barlow Nickels' house, or more than two miles south from the fault; on the road, one mile east from Lick creek of Clinch river, sharp folding was seen at a mile or more south, and it evidently continues almost to the fault, further east, the greatest complications are in the shales near the river, while disturbance appears to be wholly wanting near the line of fault; still further east on Lewis creek, near the mouth of Indian creek, and on Cavitts creek, the disturbance is insignificant, and the dip is regular for the whole distance.

The Clinch River System of Faults.

The general name here employed is that applied by Prof. Lesley to two members of the system, and it includes the Hunter Valley fault of the writer's previous memoir. No name less open to objection can be proposed; but this should not be taken as implying anything more than that in a general way the faults and the river are nowhere separated by an interval of more than a few miles.

Clinch river rises in eastern Tazewell, and flows thence through Russell and Scott into Tennessee; the distance within Virginia is, in direct line, not far from ninety miles, but by the river channel is probably one hundred and thirty or one hundred and forty miles. At about twenty miles

from its source, the stream first reaches the line of fault, near which it lies for about six miles, crossing it more than once in that interval. This is between the mouth of Indian creek and the western line of Tazewell county. At, say, twenty-five miles further west, measured directly, the river again reaches the fault, and, within the next seven or eight miles, crosses and recrosses the line more than once, if the map may be trusted. Above the former space, the interval between river and fault gradually increases to not far from six miles with the mountains of the House and Barn synclinal in it. Between the two contact spaces, the river channel-way is bow-shaped, the interval increasing rapidly to six miles on Lewis creek, and thence diminishing slowly until it disappears below Lick creek. Below the second contact-space, the interval steadily increases, and at length the river flows very near the line of the Copper Creek fault.

The Clinch Fault.

The course of the Clinch fault in Scott county is shown approximately by Buckner's ridge, composed of Knox beds, except near the line of Russell county, where it is made up of Quinnimont beds. The fault enters Russell county very near the mouth of Guest's river; is crossed at the mouth of Russell creek (Squier); is cut by Clinch river both above and below the mouth of Whetstone creek; and by Lick creek at but a little way from the river. At this last locality, the course changed somewhat to the northward, so that the fault is crossed by Caney fork of Dump creek very near Abram Kiser's house, and by Dump creek very near the mouth of Hurricane fork. Beyond this stream it was not followed. It should be found passing through the loop of Buchanan county at not more than four miles north from the southernmost projection of Big Butt mountain, on whose southerly slope Robinson fork of Lewis creek has its sources.

Thus far the structure has been comparatively simple and the direction of the fault-line almost straight—at least, its deviations can hardly be shown on a map of ordinary scale. Where first observed by the writer, on the north fork of Clinch river, in southern Scott county, the relations are apparently as shown in Fig. 4; but, within a very little way, where the road crosses Buckner's ridge, there is no upturning at the fault, the Lower Helderberg, Oriskany and Hamilton continuing to the very line of fault without change of dip. But still further eastward, the Pattonsville and Wallen Valley faults having died out, and the Stone Mountain anticlinal having become fully developed, the reversal of dip is shown again, so that the Hamilton, Lower Carboniferous and Quinnimont are crossed in succession as one goes north-westward from the line of fault. On Stony creek, also in Scott county, the same condition is shown even more clearly, for there the Knox beds have been removed by erosion for some distance, so as to expose the Silurian beds, as represented in Fig 5. Thus far the ridge marking the course of the fault is Knox, but on the road leading from Osborn's ford to Guest station, the "hanging rock" is Quinnimont.

Exposures are wanting for some distance below this Quinnimont wall on Little Stony creek, but the place of the rock in its group seems to indicate that here the Knox and the Quinnimont are in contact, as in Fig. 6 No Quinnimont occurs east from the mouth of Russell creek, and thence to the Caney fork of Dump creek, the Middle Coal measures (Lower Coal measures of Pennsylvania) are in contact with the Knox group.

The New Garden Fault.

But at or very near Bee branch of Caney fork of Dump creek, a cross-fault is given off, which extends in a south-west direction for about three miles. At that distance, it unites with the New Garden fault, which first shows itself at not far from three miles below the mouth of Dump creek, and follows very nearly the line which would have been followed by the Clinch fault had not its course been changed at Lick creek. The cross-fault gives a wedge-shape to the Knox area, the point being at Bee branch of Caney fork, and brings that group into contact with Hamilton and very probably with Clinton (?) shales. The New Garden fault is crossed by Dump creek, at barely a mile from the river, and there the Lower Carboniferous limestone is brought into contact with shales, much contorted and belonging probably to the Knox group.

No examinations were made along the immediate line of fault between Dump and Lewis creeks, though the southerly side was followed somewhat closely for several miles. A very great change takes place in this interval On Dump creek, Middle Coal measures on the north side and Devonian or Silurian on the south side of the Clinch fault are in contact; but the downthrow between the faults increases so that before reaching Big Butt mountain, the Middle Coal measures on the north side of Clinch fault are in contact with Lower Coal measures (Quinnimont) on the southerly side; while, according to Mr Squiers, an anticlinal has developed along the northerly side of the New Garden fault so as to bring the Lower Carboniferous limestone into contact with the Knox. The writer's examinations were not made in sufficient detail along Lewis creek to decide respecting the exact relation of the limestone and coal, but the strip of Lower Carboniferous must be very narrow. Mr. Squiers' diagram as given in *Science*, No 68, is reproduced in Fig. 7.

The New Garden fault continues evidently in the direct line, being crossed by Clinch river in the bend opposite mouth of Indian creek, passing south from the Baptist Valley road and thence for four miles to Low's fork of Indian, where the road turns into the valley; crossed by Cavitt's creek near the forks in Wright's valley, and, according to Prof. Lesley, by the Jeffersonville and Abb's Valley road near Capt. Frank Peery's house, six miles from Jeffersonville. As shown from mouth of Indian to Cavitt's creek, this fault brings the top of the Lower Carboniferous into contact with the Knox. The dip of the Lower Carboniferous shales is usually abrupt and no upturning was observed near the line of faulting The downthrow evidently increases eastward, for on Cavitt's creek the very

top of the Lower Carboniferous is shown and Prof. Lesley states that a coal bed is shown near Capt Peery's house on the Abb's Valley road.

The Stony Ridge Fault.

A new member of this series, the Stony Ridge fault, has its origin somewhere between Lewis creek and the line of Tazewell county; but, as the interval between Lewis and Middle creeks, about ten miles, was not examined, the place of its origin was not ascertained. In all probability, however, the anticlinal on Lewis creek marks the beginning of this fracture. The downthrow on the northerly side brings into contact with the Devonian and Silurian the Lower Coal measures (Quinnimont), which form the Big Stony ridge separating Abb's valley and Crockett's cove from Wright's valley. If one descend Low's fork of Indian from the New Garden fault, he crosses the Lower Carboniferous shales and limestones and reaches the Devonian before coming to the Lower Coal measures on Laurel fork of Indian. On Dry fork of Sandy, the whole of the Lower Carboniferous, the Devonian and possibly the upper beds of the Silurian are passed before one comes to the Lower Coal measures (Quinnimont) beyond this fault, which is crossed by the stream at barely one mile above the mouth of Dick's creek, while on the road leading to Crockett's cove, the other side of Stony ridge is reached, the Lower Carboniferous is shown at three miles from the mouth of Dick's creek and the road soon descends into Crockett's cove, which is separated from Abb's valley by a narrow divide The Stony Ridge fault is crossed by Cavitt's creek, where Silurian is present, and it must be found at the West Virginia line, since the Big Stony ridge is said to be continuous to that line

The Abb's Valley Fault.

Near the old Scott mines on Middle creek, an anticlinal occurs, which Prof Lesley has suggested may mark the origin of a new fault which he has named the Abb's Valley fault. There is every reason to suppose this true. The fault develops eastward slowly until near the Dry fork of Sandy, where the upthrow becomes very marked, bringing the Lower Carboniferous and Devonian to the surface in Crockett's cove: The fault passes at but a little way north from the forks of the road in that cove. The downthrow on the northerly side diminishes eastward, for along Laurel fork and other tributaries to Bluestone river, a thickness of from 500 to 900 feet of Lower Carboniferous shales was seen between the river and the Lower Coal measures (Quinnimont). The length of the exposed column of Lower Carboniferous increases eastward in West Virginia to the New River.

The Stone Mountain Anticlinal.

The structure of this fold makes it necessary to study it from the east westward.

The Stone Mountain anticlinal was observed first on Russell creek in Wise county; the place of its axis is concealed on Bull creek as well as

on the tributary to Guest's river crossed by the Wheeler Ford road ; but it is crossed by the Osborn's ford and Guest's Station road at little more than a mile from Guest's river; further westward it passes between High Knob and Little Stone gap. The anticlinal can be traced thence to the Tennessee line, the axis lying close to Stone or Cumberland mountain.

The fold is utterly insignificant on Russell and Bull creeks, but becomes well-marked on Guest's river. It is crossed by the Middle Coal measures on the former streams, but the Lower Coal measures are brought up in the gorge of Guest's river. Thence westward, the increase in strength is rapid and the Lower Coal measures are raised quickly to form the Powell-Stone mountain lying between Buckner's ridge and the valley of Butcher's or South fork of Powell river. The dip on the southerly side is gentle throughout, but soon becomes abrupt on the northerly side—at Guest's river it is from 5 to 7 degrees, but at Little Stone gap the rocks are almost vertical and so remain to beyond Pennington's gap in Lee county.

Three well-defined faults, described in the writer's previous memoir as the Pattonsville, Wallens Valley and Poor Valley, develop on the southerly side of this fold and cut off abruptly the clumsy Powell-Stone mountain. The Carboniferous rocks have a curved outcrop at the westerly end of that mountain, while in Powell mountain beyond North fork of Clinch river, in Wallens ridge and in the broad valley of Powell river, the Devonian, Silurian and Cambro-Silurian are exhibited. From Big Stone gap in Wise county the area affected by the fold embraces only the precipitous Stone mountain and a very narrow space directly adjoining it on the southeast. The fold from Little Stone gap to the State line is so abrupt as to resemble a fault ; its trend is at an acute angle with the lines of faulting.

Vertical Extent of the Faults.

The following table shows approximately the vertical extent of the several faults—the extremes only being given.

Clinch	8500 to 1000
New Garden	7500 to 6600
Stony ridge	2300 to ? ?
Abb's valley	1700 to ? ?
Saltville	10000 to 7000
Walker mountain	7500 to 3000

II THE GEOLOGICAL GROUPS.

Benches and terraces, beautifully preserved, were seen at many places, but the time allotted to this reconnaissance left few opportunities for making measurements of altitudes. Clinch river is bordered for the most part by high hills, so that in order to secure available grades, wagon roads usually follow the gorges of tributary streams For this reason, the existence of terraces is concealed from the traveler until the river is reached. But where, as in a few cases, the road descends directly from

the bordering ridge, avoiding the stream, the presence of terraces is distinct. The higher benches, which apparently have no relation to the river terraces, are equally distinct. Only one measurement of a higher bench was made

A few measurements of river terraces were made on Clinch, which are approximately correct.* In descending Copper ridge, in Scott county, to Osborn's ford, a bench was seen, 640 feet above low water, at Morton L. Harris' house, somewhat more than a mile from the river It carries a detrital deposit, containing small waterworn pebbles of quartz and other materials, none of them larger than a hen's egg. No other terrace or gravel deposit was seen along the road on this side of the river until the "bottom," fifteen feet above low water, was reached, as the road follows an irregular ravine; but a terrace was seen on the northerly side of the river at eighty feet above the "bottom," on which is a thick deposit of clay, sand and gravel, with many large bowlders of Coal Measure conglomerate. This terrace is conspicuous on the opposite side of the river at a little way above the ford, where there is an intermediate terrace, whose altitude was not ascertained. In descending Copper ridge to Nash's ford, almost due north from Lebanon in Russell county, river terraces were observed at 155, 40 and 15 feet above low water at the ford, and the highest one extends a long way southward from the river. Each bench bears a thick deposit of detrital matter with great quantities of bowlders. What the condition is on the north side of the river was not determined, as the road follows a deep ravine for several miles.

The only satisfactory measurement obtained along the North fork of Holston was near Laurel fork, seven miles east from Saltville. The deposit is from 85 to 90 feet above low water and contains bowlders of large size in sand and clay. The river road follows for nearly a mile. Well-marked terraces were observed along this river at many places, but no good measurements were obtained.

Sufficient evidence has been secured by measurement and observation to prove that the streams in this region are as handsomely terraced as are those of Western Pennsylvania and the adjoining parts of Maryland and West Virginia, both east and west from the Allegheny mountains; and the writer's observations in the Flat Top region of Tazewell county and the adjacent part of West Virginia satisfy him that the geologist who enters this region with time to make detailed observations, will find the higher system of parallel benches as beautifully preserved as they are in the areas of Maryland, West Virginia and Pennsylvania, described by the writer.† It is very interesting to note that these higher benches are well preserved only in softer rocks, the shales and sandstones of the Devonian and Car-

*The writer's barometer became deranged early in the examination and was useless; so that the trustworthy measurements are few.

† Stevenson. Surface Geology of Southwest Pennsylvania and Adjacent Portions of West Virginia and Maryland. Read before Amer. Phil. Soc, Aug. 15, 1879.

boniferous, as though the agency to which they owe their origin had not been long at work.

The only deposit of Quarternary age, aside from the terrace deposits, is that near Saltville, in Smyth county, where a conglomerate overlies the great mass of gypsum. This material has been exposed by a railroad cut west from Saltville, where it is said to have yielded remains of *Mastodon.* It is a conglomerate of red and blue clay, sandstone and large, mostly waterworn blocks of Knox chert and calcareous sandstone, the cement being mostly selenite. A small part only of the original mass remains, by far the greater part having been removed by erosion. No deposit of similar character was seen at any other of the gypsum bearing localities.

The deposits of gypsum and common salt occurring at Saltville and other localities on the North fork of Holston river, belong in all probability to the Tertiary. Their character and relations will be considered in another part of this memoir.

The Coal Measures.

It is unfortunate for the nomenclature of the Carboniferous that the rocks of that age were first studied and classified in Pennsylvania. Had the study and classification been made in Virginia, the nomenclature would have been different and would have been better applicable to the several areas in which Carboniferous rocks occur. The Coal measures begin with the Seral or Pottsville Conglomerate of Pennsylvania; which in that State is for the most part of little economical importance, but in Virginia and much of West Virginia is equally important with the overlaying beds, the Lower Coal measures of the accepted nomenclature. The proper terms fitted for the whole of the Appalachian area are:

Upper Coal Measures, equivalent to the Upper Coal measures of Pennsylvania, Ohio and West Virginia, begining with the Pittsburgh coal bed and continuing to the top of the series;

The Middle Coal measures, equivalent to the Lower Coal measures of the States already mentioned; and

The Lower Coal measures, equivalent to the Seral or Pottsville conglomerate of Pennsylvania, the Millstone grit of Ohio and the Quinnimont group of Virginia and West Virginia. It attains great thickness in the Virginias, where it contains the coking coals of the New river and its tributaries.

The Coal measures do not cross to the south of the Clinch system of faults though they are entangled among them. The Middle and Lower groups only are reached in the area examined.

The Middle Coal measures occur within Wise and Russell counties as far east as the line of Buchanan county. They are cut off by the Clinch fault which passes into Buchanan county between Dump and Lewis creeks, so that in that county the Middle and Lower Coal measures should be found faulted against each other north from the latter creek. The more

important coal beds described in the writer's sections * made on the headwaters of Powell river in Wise county are persistent and have been recognized as far east as Dump creek. The associated rocks show the same characteristics as on the headwaters of Powell river. Limestone appears to be absent and one of the sandstones is coarsely conglomerate.

The Lower Coal measures form the mass of Powell-Stone mountain under the Stone Mountain anticlinal in Scott county, but they quickly pass under the Middle Coal measures, owing to the rapid disappearance of that axis eastward. No exposure appears on the northerly side of the Clinch fault beyond Russell creek eastward. But the beds reappear on the southerly or upthrow side of that fault beyond Weaver creek in Russell county, as well as on the downthrow side of the Stony Ridge and Abb's Valley faults in Tazewell county. The important mines at Pocahontas on Laurel fork of Bluestone river in eastern Tazewell are in a bed belonging to this group. Scott's mines on Middle creek, Christian's mines on Laurel fork of Indian and Sayers' old mine on Dry fork of Sandy, all in Stony ridge, are in beds belonging to the Lower Coal measures. No rocks belonging to the higher group occur in Tazewell county or in Russell county east from Lewis creek. The full thickness of this group is not exposed within the area examined and the higher beds must be sought for in Buchanan county of Virginia and McDowell county of West Virginia. The passage to the Lower Carboniferous is gradual.

The Lower Carboniferous.

Lower Carboniferous rocks occur in irregular strips along the fault lines. The most important is that on the northerly or downthrow side of the Saltville fault, which tapers in width from nearly five miles on the Tennessee line to almost nothing at the easterly boundary of Smyth county. The whole section is shown best in this strip A narrow strip extends for a little way on both sides of Dump creek along the New Garden fault and another, also on the downthrow side of the same fault, begins near Lewis creek and continues eastward certainly beyond Cavitt's creek. A third strip is shown on the upthrow side of the Abb's Valley fault in Crockett's cove and Abb's valley, while a fourth develops on the downthrow side of the same fault along the waters of Bluestone river.

The section of the Lower Carboniferous as shown in Washington county was given in the previous memoir. There Prof. Safford's classification was accepted as follows:

Mountain limestone..........	1. Red shales, sandstones and thin limestones; 2. Limestones and calcareous shales.
Silicious group..............	1. Cherty limestone; 2. Protean group.

* Stevenson. Notes on the Geology of Wise, Lee and Scott counties, Virginia. Read before Amer. Phil. Soc., Aug 20, 1880.

The Protean group of Safford is practically equivalent to the Vespertine of Southern Pennsylvania and the latter name will be employed as more convenient. The group is represented by shales, sandstone and thin *coal beds*, with occasional impure limestones.

The best general section of the Lower Carboniferous is that obtained along the railroad grade from Wolf Run summit to the North fork of Holston near Mendota. This section has been given in the writer's "Reconnaissance;" but on that line the Vespertine is wholly concealed and at best is reduced to utter insignificance. The beds previously referred by the writer to the Vespertine prove to belong to the Chemung. The thickness of the Vespertine increases eastward, so that at Laurel fork, about *seven miles east from Saltville, it is not far from five hundred feet.* This group is divided almost midway by a white or grayish-white sandstone which, for a long distance, forms a low but well marked ridge along the southerly face of Brushy mountain. Some beds of very impure limestone occur in the upper shales and the passage to the more calcareous division through silicious limestones and hard calcareous shales is very gradual. *Coal beds* occur in this group at many localities between Little Moccasin creek and the eastern edge of Smyth county, but they have no economical importance.

The Vespertine is apparently of insignificant thickness among the Clinch faults. Its place is shown on Dump creek near the New Garden fault; on Indian creek between that and the Stony Ridge fault; in Crockett's cove near the Abb's Valley fault and on several other streams; but at all of these localities the group is practically wanting or has become more calcareous, so as to be merged into the middle division—a condition which, according to Prof. Safford, prevails in Northeastern Tennessee. But the whole of the Lower Carboniferous column is greatly diminished among the Clinch faults within the area examined, just as was observed in comparing the region about the headwaters of Powell river with that along the North fork of the Holston.

The limestones and upper shales are often richly fossiliferous. The collector cannot fail to get good returns on Wolf run and the North fork of Holston in Washington county; along a road following the same river for several miles below Saltville; and on Low's fork of Indian creek in Tazewell county.

The Devonian.

This age is represented by Chemung and Hamilton; the Catskill and Corniferous appear to be wholly wanting.

The Chemung is represented by sandstones varying in color from light gray to brown, the color becoming darker in the upper beds. It forms the crest of Brushy mountain and is fairly well exposed in many of the ravines cut through that mountain. A section was obtained on the rail-

road grade near Mendota in Washington county, which, condensed, is as follows:

Chemung.

1. Shales and sandstones, shales gray to reddish blue, sandstones gray and flaggy	33′	
2. Sandstone, above brownish-blue, hard, irregular fracture, flaggy with nodules of clay; below irregularly flaggy, clayey, micaceous, with large fucoids	31′	
3. Conglomerate	0′	4″
4. Sandstone, brownish, fossiliferous, with *Spirifera, Rhynchonella, Chonetes, Goniophora, Edmondia,* etc	11′	8″
5. Conglomerate, ferruginous, pebbles as large as chestnuts	0′	10″
6. Sandstone with some fossils	5′	
7. Conglomerate	0′	6″
8. Sandstones, not wholly exposed, with *Spirophyton* and *Productella* in the lower portion	268′	
	350′	

The upper part becomes harder and thicker further eastward Whether or not the conglomerates are persistent was not determined, but no fragments of them were seen at any locality beyond Little Moccasin creek, nor were any traces seen on Little Walker mountain along the road leading from Lyons gap to Chilhowie Springs.

The Chemung appears to be wholly absent along Stone mountain in Lee and Wise counties and no trace of it was found along Buckner's ridge in Scott county between the Hamilton black shale and the Lower Carboniferous limestones. But the group is present further east among the Clinch faults, for it was recognized on Indian creek at the mouth of Laurel fork, on Dry fork of Sandy and in Crockett's cove.

The Hamilton consists almost wholly of shales, is ill-exposed everywhere and no satisfactory line of separation could be found between it and the Clinton below. It was measured near Mendota, where the total thickness appears to be not far from 900 feet. The relations of these shales to the group in more northern localities could not be determined as the few fossils observed were so imperfect as not to be identifiable. The greater part of the shales, however, appears to represent the Marcellus epoch and the black shales alone remain under the Stone mountain anticlinal in Lee and Wise counties.

The Hamilton is shown on the northerly side of Little Walker and Brushy mountains; without doubt it is present on Eagle Nest and Dump creeks in Russell county as well as on Dry fork of Sandy and on Cavitt's creek in Tazewell county, but no separation from Clinton was attempted on any of those streams.

The Silurian or Upper Silurian.

Clinton and Medina alone represent this age within the area examined. In Scott, Lee and Wise counties the Oriskany and Lower Helderberg are exposed repeatedly by faults there developed on the easterly side of the Stone Mountain anticlinal. Those groups were recognized even under the Clinch fault on Stony creek in Scott county; but they evidently thin out somewhere between the Clinch fault and Clinch mountain and their disappearance eastward is equally well-marked. There is no reason to suspect a fault between Clinch mountain and Brushy mountain; on the contrary, the succession of Clinton, Hamilton and Chemung is shown on the bluff northerly side of Brushy mountain at nearly two miles east from Laurel Fork gap, many petty gaps show conformability throughout and that the Clinton passes gradually into the Hamilton. The same conditions are shown in passing from Big to Little Walker mountain. Beyond doubt, the Clinton is reached on Dump creek, Dry fork of Sandy and Cavitt's creek, but no Oriskany was observed on any of those streams, nor was anything seen which could be referred to the Lower Helderberg, except possibly a limestone found on Dry fork of Sandy at half a mile above the Stony Ridge fault The disappearance of these groups in a south-eastward direction is in great contrast with the great thickening of the Lower Carboniferous and Devonian in the same direction

The *Clinton* forms a bench on the southerly slope of Big Walker and Clinch mountain sand is the surface rock in much of the Poor valley following the foot of each mountain. Narrow strips occur along the crests of Paint Lick, East River, Dial, Deskins and possibly of House and Barn mountain The group consists of variegated shales with the whitish sandstones which everywhere lie near the fossil ore and are characteristic of the group through its extent. The fossil or "dyestone" ore is present on all the mountain mentioned. Limestone appears to be wholly absent The thickness of the group was not ascertained, but it cannot be less than 1000 feet.

The *Medina* forms the crest of Big Walker montain; of Clinch mountain, and its outliers, Rich, Garden, Short, Little Bear Town and Brumley; of House and Barn mountain; and it makes a double outcrop near the summit of Paint Lick and East River mountains.

The upper or white Medina, in irregular layers and from 200 to 300 feet thick, forms jagged cliffs. It contains a few thin layers of conglomerate, but, for the most part, the rock is very far from being coarse and some of the upper layers weather with polished surface. No fossils were seen aside from the characteristic *Arthrophycus harlani*.

The lower Medina, a mass of red to reddish-brown sandstone and shale, forms a terrace on the sides of the Medina ridges. It does not differ from the beds recognized as lower Medina in the central tier of counties in Pennsylvania, where it is sometimes called the terrace formation. The thickness is not far from 400 feet; but at all exposures the group is so badly

contorted that the true thickness can be ascertained only after detailed examination. This part of the Medina is very closely allied to the Cambro-Silurian. It contains *Ambonychia radiata* and *Rhynchonella capax* in Southern Pennsylvania; it contains the same forms, with others equally characteristic of the Hudson, in Southwest Virginia. These fossils can be collected in Lyons gap on the northerly side of Big Walker mountain in Smyth county and in Hayter's gap on the north side of Clinch mountain in Russell county. In each case the exposure is conspicuous, being at the roadside and well known to the people living in the neighborhood.

The Cambro-Silurian or Lower Silurian.

This is represented by Hudson, Trenton and Knox or Calciferous, the Utica being absent or so changed that it cannot be separated from the Hudson or Trenton. Rocks of the Trenton and Knox are the surface beds in the Great valley as well as in the broad area between Clinch mountain and the Clinch series of faults. Hudson beds occur at the northerly foot of Big Walker and Clinch mountains and outcrop around the synclinal mountains with Medina crest, which are seen in Tazewell county northward from Clinch mountain.

The Hudson consists of red to yellow sandy shales and the passage to lower Medina is wholly imperceptible The yellow shales below become calcareous and the passage to the Trenton is equally gradual. The upper beds of the latter group are very argillaceous, but the limestones become much purer lower down in the column, until the marbles are reached near the bottom of the group. These are thoroughly characteristic. Toward the bottom of the marbles some massive limestones occur containing much black chert; these mark the passage to the silicious Knox group in which are several beds of white chert and many thick beds of very hard and slightly calcareous sandstones. This is merely the Calciferous of New York, vastly increased in thickness.

No detailed section of any portion of the Cambro Silurian was attempted, but enough was observed to show that the writer's estimate of 3250 feet for the thickness of the Knox group is materially below the truth.

III. THE AREA DRAINED BY THE HOLSTON RIVER.

In going from Bristol northward toward Mendota, one rides on Trenton and Knox beds until the Saltville fault is reached at a little way beyond the Rich Valley road. The Walker Mountain fault is crossed at about four miles north from Bristol, not far from the Reedy Creek road. The red, more or less calcareous shales, forming the top of the Lower Carboniferous and dipping sharply toward the south-south-east, are exposed in the railroad cut at Wolf Run summit just beyond the Saltville fault. A well-marked anticlinal is shown on Wolf run at a few rods above the school-house; the place of the synclinal was not determined, as exposures are somewhat indefinite below Whetstone run, but long before the river has been reached

the dip is again south eastward and so continues apparently to the crest of Clinch mountain.

Lower Carboniferous limestones, of which the section was given in a previous memoir, are well shown along the run and the railroad grade beyond the river crossings, but the lower or Vespertine portion is wholly concealed. A detailed section of the Devonian beds, as shown along the railroad, is as follows, the top being at the northerly side of the little valley opening from the east.

Chemung.

1.	Shales, alternating beds of gray and reddish-blue; sandy; the gray beds hold thin flaggy sandstone; the bluish beds are more clayey and some of them are almost fissile.	20′	
2.	Sandstone, flaggy, gray, hard....	13′	
3	Sandstone, brownish blue, fine grained, hard and grit like; fracture irregular; in layers one foot or more thick; some layers contain flattened nodules of clay.	15′	
4	Sandstone, irregularly flaggy; clayey; some parts micaceous, fucoids one inch in diameter and more than two feet long.	16′	
5.	Conglomerate, pebbles from size of pea to an inch and a half, mostly white quartz, some of dark quartzite and occasionally some of blue limestone and chert..................................	0′	4″
6.	Sandstone, color and structure like No. 3	3′	
7.	Sandstone, flaggy..............	4′	8″
8.	Sandstone, in color and structure like No 3; near the top is a ferruginous layer, 2 to 4 inches thick, with *Spirifera disjuncta*, *Rhynchonella*, *Chonetes* and *Edmondia*. Specimens can be obtained only with difficulty as they are indistinct on fresh surface, while the weathered surface is very soft; fine specimens of a large *Goniophora* occur in the other parts of the rock...........	4′	
9.	Conglomerate, ferruginous, coarse, many pebbles larger than chestnuts, and mostly white quartz.	0′	10″
10.	Sandstone, flaggy; contains in middle a fossiliferous layer crowded with *Chonetes*...........	5′	
11.	Conglomerate, pebbles smaller than in the others.	0′	6″
12.	Sandstone, laminated to flaggy, light gray to bluish and reddish-gray; thin layers of laminated shale separate the sandstones; no fossils aside from bits of carbonized wood, indistinct *Calamite*-like stems, some trails and indeterminate fucoids..............................	95′	

13 Concealed....................................103′
14. Sandstone, flaggy but irregular; many layers crowded with *Spirophyton; Productella* present but not plentiful.......................... 15′
15. Concealed .... 55′

Total of Chemung........................ 350′

Hamilton.

16. Shales, areno-argillaceous; dark gray, laminated to fissile, no fossils observed except one obscure *Chonetes*.............................. 136′
17. Concealed .... 33′
18. Shales yellow to ashen, clayey to sandy........ 88′
19. Concealed in river "bottom" .... 200′
20 Shales like No. 18, laminated to fissile .... 300′
21. Shales, alternating black and gray, probably .. 150′

Total of Hamilton......................... 907′

This brings one to the Clinton rocks which form the bench of Clinch mountain, there being no Oriskany or Lower Helderberg. The Poor valley road from Mendota to Little Moccasin creek lies in Hamilton or Clinton for most of the way and reaches the North Fork of Holston at the big bend about four miles below the creek. Following the curve of the stream, the road soon touches the white sandstone of the Clinton and fragments of fossil ore occur in considerable numbers. But at somewhat more than a mile below Little Moccasin creek, the road and river pass from the Silurian into the Devonian, so that at the mouth of that creek they are in the Chemung, with a cliff of Chemung rocks on the south side of the river and the Lower Carboniferous just beyond.

On Little Moccasin, the Hamilton is shown at the roadside for some distance above Mr. Kutz' house. The Chemung sandstones form the crest of Brushy mountain, which, from this line north eastward, is an imposing ridge. The lower black shales of the Hamilton are no longer shown, but they are said to have been exposed in a mill-race not more than one-fourth of a mile above Mr. Kutz' house. Everything is concealed thence until beyond the road leading into Brumley cove, where an exposure begins as follows:

Clinton.

1. Sandstone and shales, the latter predominating; dip 27° .... 10′

Medina, upper.

2. Sandstone with thin shale and *Arthrophycus*, much of it snowy white, dip 22° .... 95′
3. Concealed...................................... 75′
4. Massive sandstone, dip 20°.......................... 45′

Medina, lower

5. Red shales and sandstones, dip 20° to 15° .... 400′

Bits of fossil ore occur along the exposure of No. 1, but the ore was not seen in place. The white Medina, with a total thickness here of about 215 feet, forms a handsome cliff on both sides of Little Moccasin gap, the dip at the northerly crest of Clinch mountain being not far from 20 degrees; thence the outcrop extends northwardly to form Brumley mountain east from the gap The red beds of the lower Medina are moderately well exposed, the higher beds are sandy and tend to be hard. The exposures of red and yellow shales belonging to the Hudson continue until Lilly's house is reached, at nearly three miles from the river, where the Trenton limestone is shown. The exposures between the house and the summit of the gap, somewhat more than half a mile, show little aside from reddish, impure, very argillaceous limestones, in which the dip gradually diminishes until, at the summit, it becomes barely 10 degrees toward south of south-east Compact limestone begins just beyond the summit and continues until the "bottom" of Big Moccasin creek. It is dark blue, weathers grayish, is in thick layers separated by thin beds of shale, and contains few fossils, only some bryozoans having been seen. Shaly limestones appear in the "bottom," but the massive beds at the base of the Trenton are soon reached and they remain in sight to Hansonville Very little chert was seen thus far.

Moccasin ridge is beyond Hansonville. White chert is abundant from the first summit of the ridge to Tarr's fork of Moccasin and the massive limestones seen along that stream contain great balls and lenticular masses of black chert. These beds are exposed on the north branch of that fork, where they dip south of south-east at from 15 to 22 degrees The lower beds shown at the summit between Tarr's fork and a branch of Copper creek have cherty reticulations on the layers so that the vertical surfaces of the beds acquires a fretted appearance. Here one comes to the shales of the Knox group and the road passes into the area drained by the Clinch river

Returning to Clinch mountain Medina forms the crest of Brumley mountain, which attains its most northerly extension almost due south from Lebanon and thence has an almost eastward trend into the "loop" of Cedar creek. There at Hayter's gap, the mountain is crossed by the road leading from Lebanon to Saltville, along which the white Medina is seen at the summit and the Clinton shales are reached at, say, half a mile from the Poor Valley road These shales form the mountain bench which fades into Poor valley and they are shown occasionally along the road until it leaves the valley to pass through Brushy mountain at nearly six miles from Saltville. The axis of the Burk's Garden anticlinal is not shown here, nor is it exposed on Tumbling creek, three or four miles further east, though there both slopes can be recognized.

Tumbling creek is formed by the union of several streams in the north-

erly extension of Clinch. No attempt was made to follow it to its head. The erosion above the first forks is very deep and there is some reason to suppose that Hudson beds have been reached ; but as this is merely conjecture the space is colored on the map as Silurian.

The Devonian and Lower Carboniferous are exposed in numerous gaps through Brushy mountain where the Vespertine's notable increase in thickness is very well shown. The upper bluff of the Chemung is more than 200 feet thick and forms a bold cliff

The "short" road to Saltville reaches the North fork of Holston at somewhat more than five miles below that village and thence follows all the windings of the stream It exposes the lower limestones of the Lower Carboniferous and excellent collections of fossils can be made at several places. Twice it passes wholly below the limestones and enters the Vespertine, reaching the black shales which contain streaks of impure *coal* As the road approaches Saltville it leaves the river and goes through a little ravine, in which the massive limestones of the Lower Carboniferous are exposed The synclinal observed on Wolf run is crossed before Saltville has been reached, but the anticlinal is concealed, as much of the Saltville basin has been eroded from it, the axis passing very near the railroad station Calcareous shales of the Lower Carboniferous make up the hills on the northerly side of the Saltville basin and are very fossiliferous. These hills are rounded and are so nearly of the same height that they may be remnants of a terrace. The hills on the opposite side of the valley are rugged, heavily wooded and show a cliff of Knox limestone.

The peculiar features of this Saltville basin, with its salt and gypsum will be discussed in another part of this memoir.

Only Cambro-Silurian rocks are shown between Saltville and Glade Spring and the dip appears to be regularly south of south-east. The Walker mountain fault is crossed at but a little way from the water-station, nearly two miles from Glade Spring. The turnpike from Glade Spring to Bristol is, for a great part of the way, very near the line between Knox and Trenton, and for miles at a time the surface material is very red, the characteristic color of this horizon and of another nearly midway in the Knox group.

Walker mountain increases in height very rapidly eastward from Glade Spring and it is soon double, one ridge being capped with white Medina and the other with Chemung. The red Medina is fairly well shown, near Lyons gap, where some of the layers contain many Hudson forms The yellow shales of the Hudson are not well shown but the limestones of the Trenton are well exposed on the Rich Valley road and thence until near Saltville, where the Knox beds are reached

In going eastward from Saltville along the Tazewell pike, one finds immediately beyond the first fork of the road an exposure of Lower Carboniferous dipping south-eastwardly, showing that the anticlinal has not been cut away wholly. Beyond the North fork of Holston Lower Carboniferous limestones are shown dipping south-eastwardly, at from 10 to

50 degrees, the rate increasing as Brushy mountain is approached. The pike follows the river to the Broadford, six miles from Saltville. The river cuts into the Vespertine shales at somewhat more than four miles from Saltville and there exposes in the upper division a *coal bed* about 3 inches thick. The hard gray sandstone underlies these shales. A *coal bed* was once opened above this sandstone on the run passing by Dr. Watson's residence about five miles from Saltville; its thickness is not known with any degree of certainty, but is believed to be somewhat more than one foot That a *coal bed* exists in the lower shales is thought to be probable, as fragments of *coal* have been obtained in the run behind the sandstone ridge. For the greater part of the distance between Dr. Watson's residence and the Broadford, the road lies in Vespertine shales, and at one place a side-cutting exposes two streaks of *coal*

Beyond the Broadford the road passes into the limestones and does not return to the shales until very near Laurel fork. There the Vespertine beds with sandstone nearly midway are shown with dip of 20 degrees in direction of the stream and having a thickness of not far from 500 feet The sandstone is between 15 and 20 feet thick, the estimate being made from a somewhat imperfect exposure. The shales rest on a conglomerate sandstone separated by a few feet from reddish brown or bluish brown sandstones of the Chemung, occuring in flags 2 to 8 inches thick, fine grained, with a somewhat conchoidal fracture and exposed along the stream above the mill dam with a dip of nearly 25 degrees. The sandstone with conglomerate layers, contains much *Spirophyton*, but no fossils were observed in the fragments of the main body of sandstone. This rock is the cliff which forms the crest of Brushy mountain from near Mendota to beyond the line of Bland county.

Débris from this cliff effectually conceals everything on the northerly side of Brushy mountain except at one place, say two miles above the gap. where, however, the wall is precipitous, so that detailed examinations cannot be made. At the same time the sequence of Clinton, Hamilton and Chemung can be made out very clearly. Clinton shales are exposed at the crossing of Laurel fork in Poor valley two miles from the gap, and there one begins to ascend the Poor Valley or Flat Top mountain which marks the course of the Burk's Garden anticlinal and divides the Poor valley. The lowest beds of the Clinton cross the anticlinal here and fragments of fossil ore are abundant at many places on the southerly side of the mountain; the lowest shales are very black The Flat Top mountain ends at a few miles east from the pike in a clumsy mass known as Bear town. The axis of the fold passes very near to the crest of Flat Top, for at a few rods beyond the summit, the rocks are dipping north-westwardly at 15 degrees. The rate increases lower down the mountain side, where a subordinate fold is shown with dip of 60 degrees on its northerly side.

Clinton shales are well exhibited on the southerly side of Clinch mountain, where two minor folds were seen, one of them overturned The dip is from 30 to 50 degrees south-eastward. Fragments of fossil ore are

abundant alongside of the road and the ore is shown in place along the reversed fold It is shown again higher up the mountain, where it carries not a little brown hematite. White Medina is reached at the crest of the mountain.

Returning now to the mouth of Laurel fork. The Saltville fault is reached just beyond the Taylor property at ten miles eastward from Saltville. Thence eastward the road and river are south from the line of fault The fault is at some distance north from the road at Mr I. H Buchanan's property, where Lower Carboniferous is represented only by the lower shaly limestones and the Vespertine shales below. On the first stream entering Cove creek below Mr Buchanan's house, the Knox sandstones extend fully one-third of a mile northward from the road. *Coal* occurs in the Vespertine shales on Mr Buchanan's farm where it was opened many years ago. The thickness of the bed is said to be 2 feet at one opening, 18 inches at another, its place is no longer exposed, but the bed lies very near to the gray sandstone. The *coal* burns nicely, but according to Mr. Buchanan it is very sulphurous.

Gypsum occurs in vast quantity on the I. H Buchanan farm, sixteen miles from Saltville, as well as on that immediately adjoining. It has been obtained on the Taylor farm, ten miles, and on the Pierson farm five miles from Saltville; all of them along this road. These deposits will be referred to in another part of this memoir

The road lies in the Knox group, east from Mr. Buchanan, and white cherty rock forms at many places the striking feature of the surface The shales of the group are shown on Black hill and the limestones were followed almost to the county line. The road and river come together again near the mouth of Lick creek

No obscurity respecting relations of the beds occurs until after leaving this main road and turning up Lick creek on the road leading to Burk's Garden Except for very short distances this part of the area drained by Lick creek is a wilderness. The course of the stream is very tortuous and one has much difficulty in determining his place The ridges all become very high and, viewed from Black hill on the main road, appear to be trending toward the southerly boundary of Burk's Garden. Brushy mountain, the Vespertine ridge and the ridge of Knox sandstones, all lying north from the Sharon Springs road, are bold and, as seen through the trees on Lick creek, abrupt. Exposures are very rare until within three miles of the summit of Garden mountain, where Clinton shales are shown. The structure is not wholly simple, for some imperfect exposures indicate the presence of more than one anticlinal in the shales. Lick creek rises on the side of Bear town, the clumsy knob in which the Medina ridges, bounding the Garden, unite

IV. THE AREA DRAINED BY CLINCH RIVER.

The turnpike, from Abingdon to Wise Court-House, crosses the ridge between Tarr's fork of Big Moccasin creek and a branch of Copper creek at a little way above Mr G. W. Morton's house The rate of dip increases rapidly in Knox limestones until at that house it becomes sixty degrees There the Copper Creek fault is crossed and the shales are shown on the long grade. The dip gradually diminishes and the marbles, first reached near the Sulphur Spring Church, remain in sight to the old Court-House, beyond which the underlying white chert and its ferruginous earth are exposed. As usual, the lower members of the marble group contain great nodules of black chert. Same of the marbles near Williams' store are of decided beauty.

Fossils are very rare, but a somewhat earthy bed on Copper ridge, not far from Dickensonville, on the road to Osborn's ford, contains *Orthis pectinella*, *O. lynx*, *Strophomena alternata* and some bryozoans.

The dips are almost regularly south of south-east on both Moccasin and Copper ridge until within about seven miles of Osborn's ford on the latter ridge, where a north-westward dip is distinct. There is difficulty in determining the structure along the crest of Copper ridge, because the rocks are deeply buried by the coating of decomposed material usually containing brown hematite, and always of a deep red color. At little more than a mile and a half from Osborn's ford the dip becomes very irregular, and the cherty limestones and calcareous sandstones are thrown into many and close folds, a condition which is continuous thence to considerably beyond the ford on the road to Guest's station; but all exposures cease in the broad "bottom" at about half a mile from the ford, so that the relation of the Knox limestone to the Lower Coal measures (Quinnimont) cannot be ascertained directly.

The "Hanging Rock" on Little Stony creek, at about a mile from Clinch river, is a massive sandstone belonging to the Lower Coal measures, it dips north of north-west at between sixty and seventy degrees, and the thickness as exposed is not far from seventy feet. The rock contains some conglomerate layers, and it is said to be underlaid by *coal*. This wall is clearly at some distance north from the Clinch fault, as for not less than fifty rods below it the hillsides show great blocks of sandstone, and a somewhat indefinite exposure seems to show the sandstone in place

The "blossom" of a *coal bed* was seen at the sharp bend of the road, one-fifth mile beyond the wall The bed appears to be one foot thick, it has shales below and a soft massive sandstone at a very few feet above. So far as exposed, the rocks have northerly dip until the open space beyond Buckner's ridge is reached, where exposures show the dip to be south of south-east. Thence to the summit of this Powell-Stone mountain no exposures were seen aside from fragmentary exhibitions of shale and sandstone. The broad, very gently undulating summit of the mountain is formed by a massive Quinnimont sandstone, fully ninety feet thick, and

varying greatly in color and structure. It is almost white on the unweathered surface, but many parts contain so much iron as to weather yellow to a considerable depth. Much of it is very soft and readily breaks down into loose sand. Many layers are conglomerate with pebbles seldom much larger than a good-sized pea, and the sand covering the mountain summit contains great numbers of these white pebbles. This great sandstone, which in all probability is the "Bee Rock," or topmost bed of the Lower Coal measures, is almost horizontal until within little more than a mile of Guest's river. From the summit to that river no exposures were found; but just above the ford at 585 feet, by barometer, below the last exposure, this rock is shown in the river bank dipping north of north-west at between six and eight degrees. So the great Stone Mountain anticlinal has diminished wonderfully from Little Stone gap, where the dip is almost vertical on this side of the axis.

Guest's station is on Little Tom's creek on the road to Gladesville or Wise Court-House. Between it and Guest's river, the exposures are poor and indefinite. A thick sandstone is shown at several places near the station. The dips grow gentler beyond the station and become insignificant towards Roberts knob, a conspicuous hill half a mile or so northward This hill is capped by a thick sandstone with conglomerate layers, while in the hollows about its base, nearly 700 feet below the top, is a *coal bed*, which, exposed in the beds of runs, has supplied blacksmiths for half a century. The bed is said to be not far from six feet thick, and its place seems to be near that of the *Kelly* or of the *Imboden* bed of the Powell River sections.

On the pike leading to Wheeler's ford, variegated shales are shown at barely half a mile from the station dipping west of north at not quite seven degrees; with them is a *coal bed*, of which the "blossom" is shown at a little way beyond. The road is but little off the strike for some distance, and soon rises to a massive sandstone, under which the "blossom" of a thin *coal bed* is shown at the first summit. Exposures, however, quickly become indistinct as the road descends to a broad basin eroded by several small branches of Guest's river. Here one should cross the axis of the Stone Mountain anticlinal, but, though not far from 650 feet below the "Bee Rock," on the crest of Powell-Stone mountain, yet that rock is not reached, which shows a flattening of the arch at the rate of certainly more than 150 feet per mile.

The Dry fork of Bull creek is reached beyond the next summit, and exposures become as unsatisfactory as can well be imagined. A *coal* blossom was seen near the summit, but thence only fragmentary exhibitions of cross-bedded or irregularly flaggy sandstones occur, which afford no definite measurements of dip A southerly dip was observed at several places, but it could not be measured. At about a mile up the Dry fork, a sandstone is shown, thirty to forty feet thick, somewhat cross-bedded, and containing small pockets of pebbles The dip is distinctly northward on Bull creek, where reached by the road, the dip being influenced by the

Clinch fault little more than half a mile away This dip becomes gentler further up Bull creek, so much gentler that the following measurements obtained in crossing from Bull creek to Russell creek are probably not far out of the way:

Middle Coal Measures.

1	Sandstone	25′
2.	Shales	10′ to 15′
3.	*Coal bed*	blossom
4	Sandstone and shale	120′
5.	*Coal bed*	blossom
6.	Sandstone and shale	100′
7.	*Coal bed*	blossom
8.	Sandstone and shale to Bull creek	180′

The intervals between these coals are very suggestive of their relation to beds on Powell river, but one is not justified in making identifications on so slender a basis.

Russell creek is reached by the road at little more than a mile from Clinch river. The dip at Mr. Dickenson's house is distinctly south of south-east. Mr. Dickenson digged *coal* on a little branch of Russell creek at about one third of a mile north from the road. The exposure is very indifferent, though it extends for more than fifty feet. Manifestly, the dip is considerable, and the coal is very much twisted. Prof Lesley, in his notes on this region, regards this coal as the same with that mined north from Guest's station.

Coal beds were seen between Russell and Whetstone creeks at 25, 85, 157 and 205 feet above the former stream, and a compact sandstone with nests of very coarse conglomerate makes the summit. The dip varies from 42 to 45 degrees on the Russell side of the ridge, but beyond the summit it diminishes rapidly, and is reversed at an inconsiderable distance. Prof. Lesley gives a diagram of this hill in his memoir. Exposures cease soon after the summit has been passed, and no more occur until beyond the river, the abrupt wall of Knox beds shows that the Clinch River fault has been crossed. The road reaches Clinch river at Kincaid's hole, whence it follows the stream to Wheeler's ford at the mouth of Lick creek. The river crosses the fault about midway between the two points. The ridge marking the course of the fault is cut away for some distance on both sides, but it quickly regains its height, and is very bold where cut by Lick creek at a little way from the river. The immediate line of faulting was not seen, but the rocks are turned up sharply on both sides, the Knox beds dipping south eastwardly at forty degrees, and a sandstone above the fault dipping even more sharply in the opposite direction. The limestones, however, are more contorted than the Coal Measures beds, for they are thrown into a succession of folds, one of which passes very near to Mr. Field's house, a mile north-east from Lick creek, where the dip is N. 40° E. at 20 degrees.

The road leading to Dump creek past the Harrold's Valley Baptist Church lies south from the Clinch fault. The area of Knox limestone begins to narrow at a little way beyond the church, and a new line of hills, composed of Devonian and Lower Carboniferous, comes in between the road and the Clinch river. These are due to the cross-fault, which unites with the Clinch fault near the Gravel Lick road at Caney fork of Dump creek This cross-fault is crossed by the Harrold's Valley road just where it emerges from the limestone ridge upon the valley of Dump creek. There one passes at once to the Hamilton shales lying south east from the Knox limestone and in contact with it The width of the limestone area here is less than half a mile, and it decreases rapidly, for no limestone crosses Caney fork, and on the east side of that stream the Clinton (?) shales are in contact with the Middle Coal measures along the Clinch fault.

A *coal bed* has been exposed on the Gravel Lick road at the mouth of Bee branch of Caney fork by Mr A. Kiser. So far as shown, it contains about four feet of good coal, but it dips at 55 degrees toward S. 25° E The line of faulting passes very near this place on Caney fork, and near the mouth of Hurricane fork further east Important developments of the coal beds have been made on Hurricane fork, where beds, answering to the *Lower Splint*, the *Imboden*, and an intermediate bed of the Powell river sections, have been opened. The thickness is reported to be greater than at localities on the headwaters of Powell river in Wise county.

The Devonian rocks are well shown along both Dump creek and Caney fork, each of which flows for a considerable distance at the northerly foot of the Brushy ridge, lying between Caney fork and the river The Chemung rocks are well shown on the road following Caney fork, where they are more fossiliferous than at localities examined in the Holston area Immediately below the mouth of Caney fork, Dump creek enters a short gorge through this ridge. The St Louis limestone is reached above the store, the Vespertine apparently being absent. The exposure of the limestone and its associated shales extends for little more than 300 feet. The New Garden fault is crossed in the ravine below the store. Thence to the river the road lies in contorted shales with occasional limestones, belonging most probably to the Knox group.

The Knox limestones dipping south eastward at thirty to eighty degrees are reached at the mouth of Mill creek on the southerly side of Clinch river. The dip is very irregular and the steeper dips of the undulations are on the south easterly side. The top of the massive limestone is reached beyond the first mill, and the shales are shown just above. These hard limestones form a line of abrupt ragged hills, which are characteristic features of the Knox topography. Exposures along this creek are not sufficient to show the structure distinctly above Jesse's mill; but the dip appears to be continuous south-eastward. The Trenton marbles are reached near the summit between this and Little Cedar creek, where some of them are remarkably handsome. The clayey limestones marking the top of the Trenton succeed, and the south-easterly dip continues to where the road

crosses Little Cedar creek. There the dip is reversed, and the same beds are shown in Lebanon. This is the House and Barn synclinal, which, however, is double as a second synclinal is crossed by the Fincastle pike at a little way east from Lebanon. The northerly synclinal is crossed again by Little Cedar creek near the second house north from the pike on the road leading to Nash's ford Thence on that road the rocks rise regularly to the top of Copper ridge. The white chert underlying the marbles rises with the road to the top of the ridge, and its fragments in the deep red detritus cover the surface This rock bears very close resemblance to the upper layers of the Medina, both in mode of weathering and in fracture; so that one unacquainted with the true condition might readily suppose Medina present along this line The top of the ridge is a synclinal, or, if not, the rocks have no perceptible dip, for the fragments of chert are abundant along the road for half a mile. They characterize the crest of Copper ridge in Scott county. Brown hematite is abundant It was mined forty years ago by Dougherty, who had a small forge on Cedar creek above Mr John Stinson's house Shales are exposed all the way from the summit of the ridge to Stinson's, where limestones are reached again.

The shales of the Knox group are shown on the north side of Clinch river, at Nash's ford, where, though crumpled as badly as the laminæ of gneiss or mica schist, they show no signs of metamorphism The road from Nash's ford to the head of Robinson fork of Lewis creek crosses Thompson creek and follows Breeze fork of that stream to its head. This road barely touches the line of the New Garden fault, reaching it only west from the fork of the road half a mile from Lockhart's store on Robinson fork. The line of the fault was not determined here within about one-fourth of a mile, as there seems to be some Lower Carboniferous limestone which was not separated from the Knox limestone. The New Garden fault lies north from the road for two miles east from Lockhart's store on Thompson's creek, but near the head of the fork next east from Breeze fork of that stream, the road approaches very nearly to the conglomerate ridge, fragments of the sandstone being abundant in the road thence for some distance. The fault line certainly passes very near the heads of the several branches of Thompson's creek. No *coal* occurs on any of these streams

The fault is crossed by the northerly branches of Robinson's fork of Lewis creek at a little way from Lockhart's store. The limestones prevail up the side of Big Butt or Big Axe mountain, fully half way up from the store. The soft limestones have yielded to the action of the many streams forming the two forks of Lewis creek, so that here is a fine agricultural space, known as the New Garden. The structure is somewhat complicated, as appears from Mr Squier's note already quoted, but the writer's examination was not made in detail, his desire being merely to supplement by a new reconnaissance the reconnaissance work already done by others Robinson's fork follows a rudely eastward course, and the

lower *coal bed* of the Quinnimont or Lower Coal measures has been digged in ravines coming from the north.

Limestone prevails along Lewis creek to its mouth, and the great calcareous sandstones with thin cherty beds so closely resembling the white Medina are well shown at the Clinch river, which is reached at Black's ford. The Trenton limestones are exposed near the top of the abrupt bluff on the opposite side of the river, and the marbles are shown immediately beyond. Soon one comes to the House and Barn synclinal, which is deeper and broader than on Little Cedar creek near Lebanon, and holds at a little way east from this road the narrow House and Barn mountain with its crest of white Medina This mountain is little more than a mile and a half north from the Fincastle pike. The easterly side of the synclinal is very abrupt and the Trenton marbles are brought up before the pike is reached at Rosedale, where one is in the red clays filled with fragments of white chert.

The pike crosses the Elk Garden anticlinal at a few rods east from the large brick house belonging to Mrs. Smith. The exposures are somewhat indefinite in much of Elk Garden, as the beautiful region eroded by Cedar creek is termed, and there may be more than one crest to the anticlinal as there are both east and west from this place. The disintegrated clayey material, carrying chert and occasionally brown hematite, prevails along the pike until very near the fork of the road leading to Saltville, so that details of structure cannot well be obtained. But on the Saltville road, near Mr. W. A. Stuart's house, the south-easterly dip is pronounced though comparatively gentle, being only fifteen degrees. It becomes undulating just beyond the next fork in the road, and for some distance the rocks are badly twisted. The Loop anticlinal, very well defined, is crossed within a little way north from the road leading to Saltville by way of Rich mountain.

The marbles of the Trenton are shown on the main road at the foot of the grade leading to Hayter's gap, and Trenton fossils abound just beyond the S-bend in the road. Thence exposures are very good along the grade all the way to the summit of Clinch mountain at Hayter's gap. The dip is south-eastward, and varies from twenty to forty-five degrees; but there are many petty crumplings of the red Medina, even the thicker and harder beds being folded closely upon themselves. The yellow more or less fissile shales of the Hudson cannot be less than seven hundred feet thick, while the red mud beds of the Medina cannot be far from four hundred feet. A fossiliferous layer occurs in the lower part of the red beds, but the fossils are not so good in weathered fragments as those found in Lyon's gap of Big Walker mountain

Red Medina and Hudson shales form the irregular terrace along the north side of the doubly-pointed mountain known at the west end as Little Bear town and at the east end as Short mountain. This terrace passes round the end of Short mountain into Ward's cove, where it is continuous with the bench along Clinch mountain; this is conspicuous in Thomp-

son's cove, and is continuous along Rich mountain to the gorge of Plum creek.

In descending from the crest of Clinch mountain into the Thompson-Ward cove by the Tazewell pike, one comes quickly to the red, yellow and grayish shales of the Hudson. The admirably engineered road doubles on itself again and again as it descends the abrupt slope until it reaches the Trenton limestones only a little way from the toll-gate. The south-easterly dip is very sharp near the summit, but diminishes so that just beyond the gate it is little more than ten degrees. A much more marked decrease occurs beyond the fork of the road near Schnapp's shop, three and a half miles from Liberty. Thence for nearly a mile and a half the dip is barely perceptible, but at that distance the north-westerly dip is very distinct, and it is especially marked where the road crosses the Dry fork. The Elk Garden anticlinal is reached near Liberty, and shows three petty folds on its crest; one near Mrs. Thompson's house, a second near Mr. Barnes' house, and a third very near Liberty

The synclinal just south from Mrs. Thompson's house holds Short mountain at the west and, at the east, so much of Rich mountain as lies west from the gorge of Plum creek, this portion, as seen from the Fincastle pike, appearing to have a synclinal structure.

The House and Barn synclinal is quickly indicated on the road leading from Liberty to the mouth of Indian creek The dip becomes abrupt on Paint Lick mountain, but good exposures are few. White Medina is reached just below the summit, and at the summit is the southerly axis of the double House and Barn synclinal. This trough is deep but very narrow, the width between the Medina outcrops being less than one-third of a mile. Clinton is present; fossil ore is shown near the road and many years ago it was mined in a small way at some distance west from this road. The south-easterly dip on the northerly side of this trough is almost vertical.

The road descends to the valley separating Paint Lick from another synclinal known as Deskins mountain, which is shorter and narrower than Paint Lick. The erosion in the valley has just sufficed to expose the Trenton along the petty anticlinal, which is reached and crossed where the road first touches the little stream. The northerly or Deskins trough of the House and Barn synclinal is very narrow here, for its axis is crossed before the gap through Deskins mountain is fairly entered, and there the first exposure shows the limestones dipping toward the south-south-east. The Trenton beds as exposed in the banks of this stream dip at from twelve to twenty degrees toward south-south east, except at one spot where a very abrupt and close anticlinal is shown. The massive limestones of the Trenton are reached at the first fork of the road, and thence almost to the next fork the road lies largely in the marbles. After turning toward Clinch river it passes into the Knox and quickly reaches the lower shaly beds Lumps of brown hematite occur here. The dip becomes steeper toward Clinch, being thirty degrees where the road first reaches the river;

thence to the mouth of Indian creek it is irregular, sometimes reaching fifty degrees.

Clinch river cuts the New Garden fault in the bend opposite the mouth of Indian creek. The Knox limestone is on the southerly side of the fault with the Lower Carboniferous shales in contact with it. On Middle creek, these shales are reported to extend to very near the coal mines. The Stony Ridge fault develops quickly, for the Devonian and the Lower Carboniferous are well shown on forks of Indian creek between the New Garden and Stony Ridge faults. The road leading from the mouth of Indian to Baptist valley lies in the shales to Low's fork of Indian, about four miles from mouth of Indian. On Low's fork one comes quickly to the Lower Carboniferous limestones, many of which are full of well-preserved fossils. The bottom of the group is reached at the main creek and the Chemung sandstones with *Productella* and *Spirophyton* are exposed just beyond on Laurel fork. The old Christian *coal mines* on Laurel fork are nearly two miles from the Baptist Valley road, and are in the Lower Coal measures or Quinnimont group. The main fork of Indian creek, rising near J B. Young's house in the "Sinking Waters" region, flows for most of its length through the Lower Carboniferous beds, though occasionally passing over to the Chemung. Very fine specimens of *Pentremites*, *Terebratula* and *Athyris* have been obtained here.

The road following Indian creek to its head crosses the summit to Dry fork of Sandy river, reaching that stream at about two miles below the Gap store on the Baptist Valley road, the distance being measured along the stream. The course of this stream is very irregular, and often follows the strike of the beds for a considerable distance The Devonian rocks are exposed at a little way below where the stream was reached, but no details were obtained respecting them or respecting a limestone which was seen at nearly a mile further down the stream.

The Stony Ridge fault is reached at three and a half miles from the Gap store or one mile above the mouth of Dick's creek. There a thick bed of sandstone belonging to the Lower Coal measures is shown at the roadside dipping at a very high angle, while at a few rods further down, but on the opposite bank, D. G. Sayers once opened a coal pit. These rocks continue to the mouth of Dick's creek, beyond which no observations were made along this stream, but the writer was informed at the mouth of that creek that no limestone occurs on the Dry fork between that place and the State line The limestone certainly makes its appearance within a very little way east from the Dry fork.

The road to Crockett's cove leaves the Dry fork at Dick's creek and turns from the creek northward within about a mile. The Lower Carboniferous beds are reached at about three miles from the mouth of Dick's creek The limestones form a high ridge, only three hundred feet lower than the Stony ridge, made up of Quinnimont sandstones. The whole strip of Coal measures, fronting on the Stony Ridge fault, is not more than a mile wide. The strip of limestone and Devonian gives the cove, a pleas-

ant little valley, which is evidently continuous geologically with Abb's valley, but is separated from it by a high divide Stony ridge separates it and Abb's valley from Wright's valley The limestone strip is very narrow as the dip is abrupt The Abb's Valley fault passes but a little way north from the fork of the road in the cove so that *coal beds* are accessible within a short distance on that side

Crossing Stony ridge from Crockett's cove one comes to Cavitt's creek. There exposures are not very clear and the line of the Stony Ridge fault was not seen* The New Garden fault is crossed very near the forks of Cavitt's creek in Wright's valley. It barely fails to show some Coal Measures rocks on its northerly side. From the line of this fault to Jeffersonville on the Fincastle pike, the only rocks exposed belong to the Knox and Trenton groups. All exposures cease soon after Cavitt's creek has been passed, so that the conditions in the House and Barn synclinal along this road are wholly concealed The southerly side of the synclinal is shown at Jeffersonville with the shaly beds of the Trenton almost vertical. The dips grow gentler as the beds ascend the Elk Garden anticlinal, which the pike crosses at about four miles east from Jeffersonville at a school-house beyond the woolen mill. Thence the dips are comparatively gentle on both sides of the axis.

East River mountain, lying north from the pike and extending eastward to New river, is held in the House and Barn synclinal, and evidently answers to Paint Lick mountain further west in the same trough. Northward from it are two others, very short ridges, both evidently Medina-capped These were not examined. East River mountain is clearly double, made up of two synclinals, the structure being visible from the Fincastle pike, but better from the summit of Rich mountain. The dip is very abrupt in each of them and the Medina stands in almost vertical walls. The thickness of Clinton cannot fail to be insignificant.

The Plum Creek gap through Rich mountain passes, in all probability, very near the end of the synclinal holding Medina, for at but a short distance further east the mountain is only the northerly side of the synclinal between the Elk Garden and Burk's Garden anticlinals. The red Medina is well shown on the northerly side of Rich mountain along the road leading to Burk's Garden and the white Medina is reached at the summit, where it is dipping south-eastwardly at 40 degrees The Clinton shales are reached at once and fragments of the fossil ore are shown in the road. The dip is reversed at a little way down the slope and for a short distance is very abrupt; but it diminishes so that at the mouth of Wolf Creek gap through Garden mountain the dip on the northerly side of the Burk's Garden anticlinal is barely 20 degrees White Medina forms a fine cliff on the sides of the gap, while the harder rocks of the Clinton are shown at the mouth Clinton beds underlie Wolf Creek valley between Garden and Rich mountains

The dip increases abruptly within Burk's Garden, the Trenton shales showing 40 degrees north-west Few exposures were observed in this "gar-

den ;" the surface is gently undulating and is covered with a deep soil. This is a beautiful cove, precisely similar in type to the anticlinal coves occurring so frequently in the regions of Pennsylvania, bordering on the Great Valley. The wall of Medina, with its terrace of Hudson and red Medina, is unbroken save by the narrow gap through which Wolf creek passes

V. THE SALT AND GYPSUM DEPOSITS OF THE HOLSTON VALLEY.*

The salt and gypsum deposits found in the vicinity of Saltville, and at several other localities eastward along North Fork of the Holston and its tributary, Cove creek, possess great economical importance and scientific interest

A basin of remarkable beauty at Saltville extends on both sides of the Saltville fault, having been eroded in hard silicious beds of the Knox on one side and in the Lower Carboniferous shales on the other ; the length is not far from one mile. The narrow westerly portion, drained by a stream rising in the Knox hills and flowing to the North fork of Holston, is separated by a well marked divide from the principal basin, which, within the memory of some of the older settlers, was occupied by a lake ; now, however, it is drained by a little stream which flows to the river. The salt works are in the larger or eastern portion

The character of the rock on the divide is well shown in the railroad cut about one-fifth of a mile from the railroad station and almost directly behind Mr. Robinson's house, where it is a conglomerate of red to blue clay, sandstone and large fragments of the chert or cherty sandstone of the Knox group These are cemented by more or less crystalline gypsum. Remains of *Mastodon* were obtained in this cut, which were deposited in Emory and Henry College, on the Norfolk and Western Railroad, eight or nine miles from Saltville This conglomerate, which is nearly 100 feet thick in a shaft sunk by Mr. Robinson just north from the railroad, has been eroded from the larger basin as well as from that portion lying west from the divide ; no trace of it occurs elsewhere in the neighborhood.

Gypsum is mined in large quantities by Mr. Robinson immediately west from the divide. It is reached at but a few feet from the surface, clearly has a covering of blue clay, and exhibits many seams of red clay, which are sometimes so extensive as to injure the market value of the gypsum. The rock in the large excavation appears to be without dip and most of the material is saccharoidal, comparatively little crystalline gypsum having been seen by the writer. The presence of gypsum on the divide, under

*I am under very material obligations to Mr. W. Musselwhite and Hon. C. T. Smith, of Saltville, for assistance in gathering information respecting the salt and gypsum deposits Mr. Musselwhite, who had charge of the boring operations in the vicinity of Saltville, generously placed all of his results at my disposal.

the conglomerate, has been fully proved by Mr. Robinson, who took out large quantities from a shaft 125 feet deep A large mass encased in clay was exhausted on this property. Seams of indurated black clay are not uncommon here and occasional fragments of sandstone have been seen, but no fragments of limestone are reported Borings made on Mr. Robinson's property were pushed to the depth of 600 feet without reaching bedded rock Salty material was obtained at 400 feet, but as the boring was dry, brine was wanting and no attention was paid to the salt. After passing through the conglomerate and the underlying blue clay, the drill pierced only gypsum and red clay.

Crossing the divide from the Robinson works, one comes to the Saltworks, whose interesting history would be out of place here Many years ago a shaft was sunk in search of salt. It passed through 20 feet of blue clay and then 195 feet of red clay and gypsum, reaching at 215 feet abundance of rock salt associated with red clay and gypsum The supply of brine proved insufficient and after a number of years a well was bored at a distance of a few yards A large body of water was struck in this at 120 feet from the surface, which immediately rose to within 40 feet of the well-curb. By advice of Mr. Musselwhite, the shaft was connected with the new well by means of a tunnel passing through the saltrock, so that now all pumping is done at the shaft and the supply of brine is apparently inexhaustible. The curb of the well is approximately 45 or 50 feet above the Holston crossing, one-fourth mile beyond the end of the railroad track, so that the almost constant level of water in the wells is practically the same with that of the Holston bed This great body of water in flowing through the rocksalt becomes almost saturated, 90 per cent; 20 gallons yield one bushel and there appears to be a minimum of bitter waters. The salt when taken from the pans is permitted to drain over them for an hour or two, it is afterwards thrown into bins where the dripping continues for several weeks The salt is then dry and no longer affected by atmospheric conditions; no rewashing is necessary. Of course, the brine is saturated with gypsum, which is precipitated upon the pans, forming a crust usually spoken of as "rock salt." This deposit, containing not a little salt, accumulates rapidly and adheres so closely to the pans that the labor of removing it adds much to the cost of producing the salt.

The saltrock is at little more than 200 feet from the surface at the well. Mr. W. A. Stuart, President of the Holston Salt and Plaster Co., states that the salt continues to a depth of nearly 600 feet.

The Pierson Plaster Works are on the Holston at nearly five miles east from Saltville. These are idle, but they were worked vigorously for more than five years and the excavations were carried to the depth of 60 feet The deposit is in the broad river "bottom," and everything points to conditions similar to those seen at Saltville. The soil is underlaid by blue clay which, wherever examined, rests on gypsum, its thickness being approximately 12 feet No deep borings have been made here to determine the vertical extent of the deposit Gypsum was once quarried directly under

a bluff on the opposite side of the river on the Miller farm, but the pits were full of water when the locality was visited, so that no information could be obtained respecting the relation of the gypsum to the bedded rocks. On the Pierson place, the gypsum rests on the shales and lower limestones of the Lower Carboniferous.

Explorations for gypsum and salt were made on the Taylor farm at ten miles above Saltville. Here again is a broad river "bottom," very similar to that at the Pierson place, five miles lower down the river. A deep shaft or boring was made here; gypsum was reached under the blue clay at a few feet from the surface and some salt was found first at about 300 feet from the surface. The original "bottom" evidently continued on the north side of a low hill, for there at some distance above the road gypsum has been obtained. The Saltville fault passes through this property and the gypsum appears to be on both sides of it, so that it rests on the calcareous sandstones of the Knox and on the calcareous shales of the Lower Carboniferous.

Buchanan's Plaster Cove on Cove creek and its tributaries is nearly six miles further east. It lies north from the road leading to Sharon Springs and occupies a broad "bottom" on Cove creek, whence it is continuous over a low divide to the "bottom" of a tributary stream on the adjoining farm. The earliest pits were sunk on Cove creek "bottom," near Mr. I. H. Buchanan's former residence. Many shallow excavations were made in order to obtain plaster for agricultural use and a shaft nearly 600 feet deep was put down by Mr. Buchanan to ascertain how much gypsum he owns. This shaft passed through only gypsum and red clay and stopped in that material. The red clay appears to be in comparatively small quantity. As at the other localities the soil rests on blue clay and gypsum has been found everywhere on the "bottom." A little drain comes down the hillside, its channel-way eroded in Vespertine shales which are exposed on both sides; gypsum occurs at its head and no doubt is continuous with the main mass below.

The "bottom" ends at the foot of the Vespertine ridge, nearly a mile from the Sharon Springs road; but a low divide separates it from a tributary which enters Cove creek at about one-third of a mile below Mr. Buchanan's present residence. The rise on this divide is gradual and a narrow strip of gypsum has been traced over it in a succession of pits. Some exceedingly impure limestone is shown at a little distance from the gypsum, but the latter evidently rests on the Vespertine shales. The stream rising on the other side of the summit flows over the shales into the next farm where it has a broad "bottom." Mr. Buchanan has digged gypsum at the very head of this stream and the work continues down the stream. The quarrying has been conducted in a very wasteful manner on the next farm, where a great number of shallow broad pits sufficiently show the enormous amount of gypsum present. Blue clay, often very tough, everywhere overlies the gypsum and at several pits seems to enclose it. The deposit ends on this stream at somewhat more than a third of a mile from

Cove creek, and all of it is north from the Saltville fault, so that it rests wholly on the Vespertine shales. Mr. Buchanan states that gypsum has been digged in very considerable quantity at the road, where this stream enters Cove creek. That gypsum rests on Knox beds. How extensive it is has not been ascertained.

No investigations have been made here with a view to the manufacture of salt and no notes were taken respecting the depth at which salt was first found Mr. Buchanan's shaft is now full of water and no examinations can be made. There is, however, no room for doubting the occurrence of salt there in the deeper portions. Mr Buchanan says that the waste material, clay and impure gypsum, was thrown into heaps, to which cattle and sheep resorted, licking them with great avidity. The gypsum is mostly saccharoidal, but there is a good deal of crystalline also. As the latter clogs the mill in grinding it is much disliked and is thrown aside as worthless. Much lies in the waste-piles on Mr Buchanan's farm which would be excellent for collections.

Mr. Musselwhite states that no gypsum has been found east from this cove on the road to Sharon Springs, and that no gypsum has ever been obtained in the Rich valley which follows the northerly foot of Big Walker mountain

Resume

Such are the details obtained either by personal observation or by careful inquiry of those who are familiar with matters no longer open to examination. The facts with reference to the occurrence of these gypsiferous deposits may be summed up as follows:

First The gypsum deposits are not beds of Carboniferous or Cambro-Silurian limestones changed into gypsum.

Second. These deposits occupy deep basins, which have been eroded in Lower Carboniferous shale or limestone, or in the hard, slightly calcareous sandstones of the Knox group. In at least two localities, branches protrude from the main body into drains or ravines, so that the horizontal plan resembles somewhat the splash made by throwing soft mud against a wall.

Third. The character of the deposit is wholly independent of the rocks on which it rests.

Fourth. The gypsum occurs in irregular masses, encased in red marly clay, which penetrates the gypsum to a variable distance, there is less of this clay in the eastern basins than at Saltville

Fifth. At a variable depth, salt occurs with the gypsum, and this salt contains very little of iodides or bromides.

Sixth Blue clay overlies the gypsum at all localities yet examined

Seventh. No fossils of any sort have been found thus far in the gypsum, its encasing red clay, or in the overlying blue clay, but, just west from Saltville, a conglomerate, cemented by gypsum, occurs, in which remains of *Mastodon,* have been found; this overlies the blue clay, and encloses many fragments of both blue and red clay.

Eighth. These gypsiferous deposits occur in the vicinity of the Saltville fault

Age of these Deposits.

The basins occupied by the gypsum deposits are very deep, extending more than 600 feet below the present surface at Saltville; more than 400 feet at ten miles east from Saltville; and more than 600 feet below the surface in Buchanan's cove—those being the depths to which exploration has been carried at the several localities. These basins must have been eroded at a time when the continental elevation was greater than now or when the drainage was in a very different direction. It may be suggested that they are great "sinkholes," similar in kind to those which occur so commonly in limestone districts. But there is no probable outlet for waters eroding caverns at more that 600 feet below the present drainage lines; more, the limestones are too far under Pearson, Taylor and Buchanan for their removal to have much effect. The gypsum at those localities rests on Vespertine, between which and the nearest limestones the whole Devonian, Silurian and the upper part of the Cambro-Silurian intervene.

Nothing has been obtained going to show when these basins were eroded. The extent of erosion prior to their formation was very great, for the Coal measures, Lower Carboniferous, Devonian, Silurian and much of the Cambro-Silurian had been removed from the upthrow side of the fault—a very gradual process, as gradual possibly as that by which the fault itself was produced. But nothing can be predicated on this. Geologically speaking, the time required for the removal of 10,000 or 12,000 feet of rock is comparatively short, as abundantly appears from the enormous erosion done in the Colorado area since the later Tertiary and on the Canadian plains of New Mexico since the later Pliocene, where a greater amount of rock has been removed during a period probably no longer than that during which the great faults of Virginia were forming.

One might at first suppose that the blue clay may eventually afford some clue by yielding fossils. It immediately underlies the Quaternary conglomerate of the Saltville basin and everywhere rests on the gypsum. But certainly it was not formed at once after the gypsum ceased to be deposited. The conditions observed on the Buchanan and Taylor properties show that a very considerable thickness of gypsum had been removed by erosion before the blue clay was deposited; possibly more than 100 feet, the strings or branches of gypsum protruding into the little ravines being remnants which had escaped erosion. In every instance, the blue clay rests on eroded bosses of gypsum and does not invade the deposit to a depth of more than a few feet, the investing material being the red clay, which clearly has a different origin. It is sufficiently evident then that a gap exists between the close of the gypsum-making and the beginning of the clay deposit that positively prevents any linking of them together.

But the amount of the erosion and the general relation of the gypsum to the blue clay, with the relation of the latter to the Quaternary conglomerate, suggest that the gypsum is not older than the Tertiary; until some fossils have been discovered, however, the question of age must be re-

garded as undetermined. Fossils may be present and may have been overlooked by the workmen; examinations by geologists have been of the most casual sort, so that the statements respecting absence of fossils are necessarily of no positive value. Capellini's studies in the Tuscan deposits, as well as elsewhere in Italy, bear this statement out; for after the gypsum and its associated marls had been pronounced non-fossiliferous by many geologists, an extensive fauna was discovered, which he has described and illustrated in his numerous memoirs.

Origin of these Deposits.

So long as these deposits could be regarded as of Lower Carboniferous or Cambro-Silurian age, there seemed to be little difficulty in accounting for them as beds of limestone changed by the action of acid springs or as beds of gypsum actually deposited as such from the ocean waters. Improbable as the former explanation might appear in this region where sulphurous springs issue in many places from limestone without having any gypsum in the vicinity, yet it is altogether possible, for Capellini* tells of instances near Cervaro in Naples, where, by the action of hot sulphur springs, nummulitic limestone has been converted from crystalline into fibrous gypsum, containing sandy veins and semi-opal derived from silica of the nummulites. Occasional masses of unchanged limestone were seen there, doubtless owing their preservation to some difference in composition.

The other method of accounting for the beds is even more readily to be received. Newberry has shown for a part at least of the Salina† gypsiferous deposits that the gypsum was most probably deposited as such in lagoons, and the writer has described beds of saccharoidal ‡ gypsum deposited as such in the Carboniferous and Triassic of Colorado.

But this deposit belongs not to any regularly bedded series, so that some other explanation must be sought. Any suggestion of deposit from seawater must be set aside at once for the deposit is fully 1700 feet above tide and there is practically no bitterwater in the brine at Saltville. We have to explain the occurrence of gypsum, rocksalt, red marly clay; the gypsum occurring in great amygdules at 1700 feet above tide, in the vicinity of a great fault, and with many sulphur springs still active in the region.

The general mode of occurrence is very like that of the Permian deposits near Recoaro in Venice, as described by Taramelli §

The gypsum is in amygdules of great size, accompanied by pale sandy marl, looking like volcanic ash, but distinctly calcareous. Capellini‖ in his

*Capellini Ariano e dintorni. Cenni Geologici sulle Valle dell' Ufita, etc Mem dell' Accad. di Bologna, 1869, pp 15 et seq.

†Newberry. Report of the Geological Survey of Ohio, Vol. ii, p 194.

‡Stevenson. U S. Explorations west of the 100th Merid, Vol. iii, pp. 364, 379, 380

§Taramelli Geologia delle Provincie Venete, 1882, pp. 69 et seq.

‖Capellini. La Formazione Gessosa di Castellina Marittima. Mem Accad. Sci. di Bologna, 1874, pp 16 et seq.

interesting memoir on the gypsum deposits of Castellina Marittima tells of conditions very similar. The amygdules of gypsum are of large size, and are associated with marly gray to yellow clays. He ascribes the formation of this gypsum to the action of sulphur springs on calcium carbonate held in solution; so that the carbonate was changed into sulphate and deposited as such in the littoral lakes of the Middle Miocene. Dr. Newberry, on the authority of Dr J. M Locke, has informed the writer that something very like this is going on in Lake Utah, where the calcareous wash from the Wasatch mountains at the east meets the pyritous wash from the Oquiah range at the west, so that calcium sulphate is depositing in the lake.

The origin of the Holston gypsum is to be accounted for in some similar way. Several deep basins were occupied by lakes; that of the Saltville basin received not a little calcareous matter from the Lower Carboniferous beds forming its northerly shore, and some doubtless was received from the wash of the Knox beds on the southerly shore; in the basins further east the calcareous matter derived from the wash should be far inferior to the argillaceous matter. But the composition of the gypsum shows *less* of the red clay at Buchanan's than at Saltville The principal source of the calcareous matter must be looked for not in the wash from the shores, but in springs That calcareous springs can produce deposits as extensive as those of this region is sufficiently shown by the extensive deposits around many of the springs at the far West The calcium carbonate in solution would be converted into calcium sulphate by the sulphurous springs also issuing from the fault, and the gypsum would be deposited as such

The red marly clays were derived from the wash, and are more abundant at Saltville, where the soft red shales at the top of the Lower Carboniferous are fully exposed on the northerly side of the basin Undoubtedly not a little of the gypsum is derived from this wash, but, comparatively speaking, the quantity must have been insignificant. Had the basins been very large, such as that of the ancient Lake Lahontan, so well described by Mr. I. C. Russell,* the detrital material would have been dropped at the shore, and the calcareous matter would have been deposited by itself in the middle of the lake; but the Holston basins are very small; the region is one which always had a great rainfall, so that the wash of sand and clay would be very considerable. The amount of foreign matter and its distribution in the gypsum are conclusive. The sodium chloride must have come from springs and it may have been derived from the great sandstones under the valleys. Whatever was the source, the supply appears to have been cut off at about the same time throughout the whole region, for the top of the "saltrock" is reached at 215 feet at Saltville and at 300 feet in the Taylor shaft or at approximately the same absolute level.

Cafici, in his observations of the Sicilian gypsiferous deposits, and Capellini, in his studies of the Tuscan deposits, find evidence of alternating periods of activity and quiet in the springs; for the fossiliferous shales

*Russell. Sketch of the Geol. Hist. of Lake Lahontan. Third Annual Report U. S. Geol. Surv, 1881, 1882

and marls occur between the gypsums. The opportunities for examination in the Holston region are so limited that one cannot determine whether or not any such variations in activity of the springs occurred there.

Note.—The map accompanying this memoir is based on the old State map as used by Mr. Boyd in his Resources of Southwest Virginia, but the scale has been changed and a number of alterations have been made. It is still very inaccurate, but no better map is in existence. I have to acknowledge the courtesy of Maj. Powell, Director of the U. S Geological Survey, and of Mr. Gannett, Chief Topographer of the Survey, in supplying photographic copies of the unfinished maps of the region. These have afforded real aid in working out the geology at localities where the other map had led me into serious error.

Some Notes Respecting Metamorphism By John J. Stevenson, Professor of Geology in the University of the City of New York

(Read before the American Philosophical Society, December 7, 1884.)

I have gathered together in this paper a number of notes made from time to time respecting the effect of certain agencies, which are regarded usually as especially active in inducing metamorphism of rocks.

Effect of proximity of Metamorphosed Rocks.

The following section was obtained on Four-mile creek, a stream entering South Park, Colorado, from the west; the rocks are Siluro-Cambrian:

1. Limestone, much altered.
2. Conglomerate and quartzite, imperfectly exposed
3. Concealed, with occasional outcroppings of quartzite.
4. Quartzite.
5. Limestone, arenaceous, somewhat changed.
6. Sandstone, unchanged, light gray.
7. Sandstone, unchanged, shaly partings, dark gray.
8. Sandstone, slightly changed with layers of unchanged shale
9. Sandstone, somewhat changed, very micaceous, dark.
10. Quartzite, mostly white, lines of cleavage distinct.
11. Granite and gneiss.

The total thickness of section is not far from 350 feet. A structureless quartzite rests on the Archæan, but above that the degree of change di-

minishes to the top of No. 6, that and the underlying stratum being wholly unchanged, so far as the eye could determine; above these the change is distinct, for Nos. 2, 3 and 4, are perfect quartzites so far as they are exposed. The agent which can convert sandstone into structureless quartzite does not suffice to effect much change in limestone, for the limestones of the section are rendered merely brittle, there being no trace of crystalline structure.

Rocks of the same age at the head of West Fork of Taylor river, also in central Colorado, show a somewhat similar condition:

1. Quartzite, black.
2. Quartzite.
3. Shales, somewhat arenaceous and almost unchanged.
4. Quartzite, structureless
5. Sandstone, little changed.
6. Quartzite, on top completely changed; middle, the change is slight; but at base the quartzite is structureless.
7. Granite.

The total thickness of section is not far from 250 feet. The conditions are more marked here than in the previous section, for in No 6, which appears to be a continuous mass, the change is least in the middle. No. 5 is a thick stratum lying between thicker ones, which have been wholly changed, yet it seems to be wholly unchanged.

The unchanged rocks in each section are more or less argillaceous

The Cretaceous rocks in South Park, Colorado, show some interesting differences, though the conditions appear to be precisely the same. On the west side, where the South fork of the Platte river breaks through a low ridge, the sandstone and conglomerate of the Dakota rest on gneiss and show no evidences whatever of having been subjected to any metamorphosing agent; on the east side near the Sulphur Springs, the same beds are found in the same relative position, but entirely changed, the conglomerate being converted into remarkably beautiful quartzite. The Colorado limestone on this side has been changed in color and it breaks along well defined planes. The Dakota beds are shown west from the main divide at the junction of Taylor and East rivers, where they are resting on gneiss and are wholly unchanged.

The Carboniferous rocks rest directly against the Archæan at the head waters of the Purgatory river in Southern Colorado, but no evidence of metamorphism appears there, which is perceptible to the unaided eye. So also on Cebolla creek, a tributary to Mora river in New Mexico, limestone of Carboniferous age is seen resting on granite and wholly unchanged; but on Manuelitos creek, only a few miles away, the following section is shown:

1. Sandstone and shale, wholly unchanged
2. Sandstone becoming quartzite below and passing imperceptibly into

3. Silicious limestone, which can hardly be distinguished from quartzite by mere optical examination.
4. Concealed, 25 feet.
5. Gneiss.

The total of the section to the gneiss is about 140 feet. The same section is exposed by a fault at not more than a mile further down the stream, but no traces of change appear

Effect of Pressure during Plication.

The stratigraphical disturbance in the vicinity of Rock creek, a stream flowing amid the Elk range of central Colorado, is extraordinary The structure was worked out by Mr. Holmes of the U. S. Geological Survey, whose discussion of the matter is one of the best relating to complicated stratigraphy.

In 1873, the writer made a section across this strange fault-fold

Beginning at the mountain top on the east side of the valley and descending towards the stream, fifteen strata of sandstone and limestone were found, all wholly unchanged ; the sixteenth in the series is a slightly altered sandstone, while the seventeenth and eighteenth are thick sandstones, for the most part unchanged, but embracing thin layers of quartzite. Below these are the Cretaceous shales, in the middle of the fold, along the synclinal, but wholly unchanged.

Beyond the stream the rocks are all changed to some degree and the succession is :

1. Quartzite, structureless
2. Quartzite, imperfect
3. Silicious limestone, unchanged
4. Quartzite.
5. Concealed.
6. Quartzite.
7. Shale unchanged
8. Gypsum, anhydrite
9. Limestone, shaly, unchanged.
10. Quartzite.
11. Gypsum, anhydrite.
12. Sandstone, somewhat changed.
13. Sandstone, much more changed than the last.
14. Gypsum, anhydrite.
15. Quartzite, showing no trace of lamination
16. White quartzite
17. Quartzites alternating with thin limestones; former wholly changed ; the latter almost unaffected.
18. Limestone, wholly unchanged
19. Quartzite wholly changed.

There are no great dikes here, nor are the beds very near the Archæan

rocks The length of the section as given is not far from 1100 feet. The extent of change increases with the distance from the median line of the fold.

A fact observed here is very worthy of note One of the conglomerate sandstones of the section contains fragments of Quartzite sometimes resembling the Silurian quartzites seen elsewhere, but oftener resembling the Carboniferous quartzites of the vicinity. The age of the fragments is unimportant in this connection ; it suffices to know that the metamorphosis had taken place before the conglomerate in which they occur was formed. On Eagle river, not many miles eastward from Rock creek, the Carboniferous conglomerate contains fragments of Silurian quartzites and the unchanged Carboniferous rocks rest on the wholly changed Silurian beds. It appears hardly probable that anything connected with disturbance or folding of the rocks caused the metamorphosis of the earlier beds, for there certainly was no upheaval or serious disturbance between the close of the Silurian and the Carboniferous, as the two series are conformable, though the succession is far from being complete

The Dakota sandstones are almost wholly metamorphosed into quartzites along the Conejos trail, which crosses the San Juan mountains from Tierra Amarilla in New Mexico to Conejos in Colorado. The most of it is a structureless quartzite Along the same trail, the Triassic beds are metamorphosed.

The Dakota sandstone is quartzite on the easterly slope of the Sangre de Cristo mountains in Southern Colorado.

But in many instances the severest twisting and plication appear to have been without any influence whatever. The Dakota is turned on edge and often faulted for a long distance along the easterly foot of the Culebra range of mountains in Southern Colorado and Northern New Mexico, but it shows no change anywhere except where, for a little distance, it has been affected by the proximity of a dike.

The Middle Appalachian region affords many instances in which shales and sandstones have been subjected to enormous pressure and distortion without any apparent effect.

Along Clinch river in Russell county of Virginia, in the vicinity of the Clinch fault, the shales of the Knox group are twisted as badly as mica schists are in many localities, yet they show no signs of metamorphism and have not even new planes of cleavage. The Lower or Red Medina on Clinch mountain in the same county is thrown into close wrinkles which affect even the harder beds, yet no approach to change is manifest to the eye Within the same region in Pennsylvania, the conditions are similar In Bedford county, of Pennsylvania, the Red Medina is thrown into extremely close folds for a distance of more than 1000 feet along the easterly side of Evitts mountain, but no change appears in the rock. At a little way further east are the shales of the Hudson and Utica standing on edge but not showing slaty cleavage. There is, however, a change in the Utica, the black shales, which is noticeable here as well as further east

on the easterly side of Tuscarora mountain in Franklin county of Pennsylvania During the folding, the rock yielded and was broken into great masses which moved on themselves so as to permit the folds to be made. These planes of fractures are the "dry seams" of the tunnel-men.

This condition is equally well marked in the great sandstones of the region. No traces of it appear on the surface, aside from the presence of occasional planes along which silicious matter appears to have been deposited and which have a slickensided surface But in the great tunnels now driving by the South Penn Railroad Company, the true condition is sufficiently clear. The crush broke the sandstones into enormous wedges; during the folding these were rubbed against each other so as to polish the faces and to fill the crevices with clay. These are a source of danger and anxiety to those driving the tunnels and they render arching necessary where the rock is such that arching would be thought wholly unnecessary.

The fracturing in the Utica shales is even more noticeable, for there the masses are much smaller and the fragments which fall from a tunnel roof, even when the beds are standing at ninety degrees, vary from five to five hundred pounds weight, while the slates show the results of the terrible pressure by their slickensided surfaces, separated by not more than an inch. Yet despite this terrible pressure, the black shales of the Utica appear to have lost none of their carbonaceous matter and, on the freshly fractured surface, do not differ from shales of the same age in Central New York where the disturbance has been practically nothing whatever.

The sandstones of the Vespertine and Upper or White Medina, in like manner, show no change whatever. The White Medina in its upper portion resembles quartzite, but this is due to conditions during its deposit.

Effect of Contact or Proximity of Eruptive Rocks.

The influence of eruptive rocks is as variable as that of the other agencies. Near the head of East river in Colorado, not far from the head of Rock creek, a narrow dike of trachyte cuts the Colorado shales, and they have been changed into true slate for many feet on each side. At other localities on the same stream, enormous trachytic overflows, nearly two thousand feet thick, rest on the shales. Metamorphism extends to a distance of only a few inches. Nor indeed do the shales show any change as the results of the enormous pressure of the overlying trachyte.

Dikes are very numerous in the San Juan region of Southwest Colorado. The eruptive rocks appear to equal the sedimentary rocks in quantity. The effect on the latter is very marked, for in many places the metamorphosis is so great that one has difficulty in determining that he is not examining an eruptive rock

In the vicinity of Old Baldy, a trachytic mass just north from Cimarron creek in New Mexico, there are many dikes which reach far out toward the east, invading the whole of the Cretaceous from the Dakota to the Laramie. There, Colorado shales have been changed into true slates;

the purer sandstones into quartzite and the micaceous sandstones, thus altered, so resemble granite that one examining only a hand specimen might well hesitate before deciding the name of the rock. The miners in the region stoutly maintain that this is granite.

Intruded sheets of basalt have converted coal into coke in Purgatory, Dillon and Upper Canadian cañons in the Trinidad coal field of Colorado and New Mexico. On the northerly slope of the Placer mountains in New Mexico, an enormous dike of trachyte has converted a bed of coal into anthracite for a distance of certainly one-fourth of a mile.

But in many cases the effect is imperceptible. Along the Upper Arkansas in central Colorado, especially in its great cañon passing through the east side of the Sangre de Cristo mountains, known further north as the Park range, numerous instances of contact between eruptive and sedimentary rocks were observed. The Carboniferous rocks dip very sharply near Pleasant valley and an overflow of basalt rests on their upturned edges. There seems to be no alteration at the line of contact. At a little way further up the river, an enormous dike breaks through the same sandstones and overflows broadly; the line of contact is well-shown on each side. Careful examination disclosed no perceptible alteration in the sandstones. At several localities within this cañon, the great sheet of lava, which extends from the eruptive area at the south-west almost continuously into South Park, is frequently seen following the eroded surfaces of the sandstones and coming down almost to the level of the road. Many opportunities occur for examination of the contact, but one rarely finds the alteration extending to more than a very few inches. These rocks are micaceous and contain a large proportion of argillaceous matter.

On Mount Lincoln, near South Park in Central Colorado, a great dike can be seen for nearly 2500 feet above the timber line, passing directly through the Silurian and Carboniferous beds. The effect on the Silurian cannot be determined as some other agent has metamorphosed those beds throughout. The change in the Carboniferous is insignificant. The limestone is altered slightly in color and is somewhat brittle, while the sandstone has become an imperfect quartzite. In each the change is perceptible for a very few feet.

In Dillons cañon, New Mexico, a sheet of basalt is shown between sandstones at a mile from the cañon's mouth. No effect whatever has been produced on the character of the rock, though vapor holes are present, showing the intense heat; yet at a short distance further up the cañon the same sheet has converted into fine quartzite the sandstone on which it rests.

In the Upper Canadian cañon a sheet of basalt has converted a coal bed into coke, but another at a few feet higher up the hill has had no influence whatever on the rock in contact with it.

On the northerly slope of the Placer mountains a narrow dike of basalt cuts through the Laramie beds, its course being fully exposed for 38 feet, including two thin beds of coal. No effect whatever has been produced on the coal even at the line of contact.

Twelfth Contribution to the Herpetology of Tropical America.
By E. D Cope.

(Read before the American Philosophical Society, Dec 19, 1884)

I. On a Collection of Fishes and Reptiles from Monterey, Nuevo Leon, Mexico.

The following list represents a collection which I made when on a visit to Monterey, in the month of November, 1883. The locality is an important one from the point of view of geographical distribution, as it is on the borders of the two great realms, the neotropical and the nearctic How well it expresses this position may be seen from the accompanying identifications.

Pisces

Amiurus olivaris Raf, a large specimen obtained in a fresh state, from the Salado river.

Campostoma formosulum Girard

Hybognathus civilis, sp. nov.

Scales 6–41–4; Radii; D. I 8, A I·8. Length of head equal depth of body, and contained in the total length (including caudal fin) 5.25 times. Eye contained 3 66 times in length of head, and 1 25 times in interorbital width; its form oval The muzzle is obtuse at the extremity, and overhangs a little the premaxillary border. The mouth is small and horizontal, and the lips are not sharp-edged. The extremity of the maxillary bone is opposite the anterior nareal opening, not reaching the orbit by some distance. Infraorbital bones narrow Frontal region convex transversely, with two rows of tubercles on each side of a smooth median space in the males, the two interior rows coming together on the middle line on the top of the muzzle. The rays of the pectoral fin are thickened in the male, and they do not reach the ventrals. The ventrals do not reach the vent, and their anterior origin is a very little in front of the anterior origin of the dorsal fin. The gular isthmus is wide.

Total length, .078; do. to opercular border, .010, do. opposite base of dorsal, .032; do. to opposite base of anal, .044; do. to base of caudal, .065.

Color, dusky above; below silvery with dusky shades, fins yellow at the base, unspotted.

This species is very abundant in the creek that rises in a large spring in the city of Monterey Its nearest relative is the *H flavipinnis* Cope from Western Texas. The latter differs in the larger eye, which enters the head 2.66 times, and equals the interorbital space, which is flat and not convex. There is also a distinct lateral band in the Texan species, which is in the *H civilis* only faintly indicated. The characters are constant in small as in large specimens.

CLIOLA MONTIREGIS, sp. nov.

Related to the *C. jugalis* Cope, but more elongate in form, and with but eight anal rays Scales 6–36–2½ ; Radii ; D. I. 8 ; A. I. 8. Head entering length (without caudal fin) 3 5 times ; depth entering the same 3.75 times. Eye entering head 3.2 times, and into interorbital width 1.2 times. The scales are rather closely imbricated. The dorsal outline is gently arched from the muzzle to the last dorsal ray. Caudal peduncle stout Mouth terminal, descending backwards, the extremity of the maxillary bone extending to the line of the anterior orbital border The anterior insertion of the ventral is a little in advance of that of the dorsal fin. Interorbital region a little gently convex, with scattered tubercles. The pectoral fins reach the ventral, and the latter the anal.

Total length, .049 ; to opercular edge, 011 ; to line of first dorsal ray, .021 ; to do. of anal fin, .030 ; to base of caudal, .038.

Color like that of a young *C. analostana*, without spot on dorsal fin. Generally silvery, darker above, with an indistinct plumbeous lateral band. No distinct caudal spot. No spots on fins.

The pharyngeal teeth are, some of them, lost. They appear to have been 4–4 They have an obtuse grinding surface and no crenations.

TETRAGONOPTERUS ARGENTATUS Bd. and Gird.

Very abundant in the city of Monterey. The pectoral fins do not reach the ventrals, as they are said to do in the above-named species by Jordan (N Am. Ichthyology, 255). In this respect, this species resembles the *T. brevimanus* of Gunther, which appears to be very near to the *T. argentatus*, and to which my specimens may be referable. I am not, however, sure that the species are distinct.

HEROS CYANOGUTTATUS Bd. and Gird.

Very abundant in the city of Monterey, where it reaches seven inches and more in length. It is a good pan-fish, and is the Mohaira of the people.

LEPOMIS HAPLOGNATHUS, sp. nov.

Scales 6–35—14–15 , Radii ; D X–11 ; A.III–9. Inferior pharyngeal bones narrow, with conical teeth ; gill-rakers obtuse, rather stout ; no supplementary maxillary bone, nor palatine teeth.

Dorsal and ventral outlines subequally convex ; form oval. Lower lip more prominent, maxillary bone reaching anterior line of orbit. The latter enters the head (without flap) three and a half times, and the nearly flat interorbital space once only. The depth enters the length, without caudal fin, two and three-fifth times, and the head (without flap) enters the same 3.25 times. The ventral fin barely reaches the anal. The extremities of the soft dorsal and anal are of the same length, and fall far short of the base of the caudal. The edge of the latter is notched at the middle, and the lobes are beveled at the free borders. The opercular flap is rather long. Six rows of scales on the cheek.

The color is olivaceous, yellowish below. A blue band crosses the preorbital bone above, and another follows the premaxillary border and passes along the inferior border of the orbit. Below this, another blue line crosses the cheek Other blue bands have been obscured by the alcohol. Flap, plain black

Total length, M. .113, to end of flap, .033; to line of anal fin, 054; to base of caudal fin, .091.

This species much resembles the common *L. pallidus* Mitch. of the United States It has, however, about ten less scales in the lateral line, and the gill-rakers are rather short and quite obtuse. It is also allied to, but still more different from, the *L humilis*.

This species is the most southern of the group to which it belongs, and, excepting the species of Micropterus, the first known from Mexican waters.

BATRACHIA.

RANA HALECINA Kalm.

REPTILIA.

PHRYNOSOMA CORNUTUM Harl.

The most southern locality for this species.

HOLBROOKIA TEXANA Trosch.

The most southern locality for this species.

SCELOPORUS TORQUATUS Wiegm.

This species is abundant at Monterey, and also at Laredo, on the Rio Grande

SCELOPORUS VARIABILIS Wiegm.

The most northern locality for this species.

REMARKS.

In this small collection we have a mixture of the nearctic and neotropical faunæ. Among the fishes, well-known northern genera swim in the waters of Monterey with the two neotropical types Heros and Tetragonopterus Two of the reptilian species are the common forms of Texas, while the *Sceloporus variabilis* is a species of the Tierra Caliente, which extends as far as Tehuantepec.

II. JALAPA, VERA CRUZ, Flohr.

The following species were presented to me by my friend Mr. Flohr, of the city of Mexico Some of the species are rare or new.

EUMECES FURCIROSTRIS, sp. nov.

The characters of this species may be best understood by the following table of the Mexican and Central American species of this genus:

I. No nasofrenal plate

a. Three supraorbital plates.

Frontal transversely divided; twenty-four rows of scales; a pale-bordered

black lateral band; three light stripes on head, the median bifurcating and joining the lateral ones on the muzzle......*E. furcirostris* Cope.

Frontal not divided, twenty-four rows of scales; a brown lateral band, pale-bordered above, on head and neck ....*E. dugési* Thominot.

aa. Four supraorbitals.

Rows of body scales in twenty-two to twenty-four rows; a lateral black band, pale bordered above and below, head narrow................ *E. brevirostris* Günther.

Rows of body scales twenty-four; a dark, pale bordered lateral band, a median band bifurcating on muzzle .... *E lynxe* Wiegmann.

Rows of body scales twenty-eight, a dark lateral band, head wide; large ....*E sumichrasti* Cope.

II. A nasofrenal plate.

Body scales in twenty-one rows; two median dorsal rows, wider; postmental not transversely divided.................*E. schwarzei* Fisch.

Body scales in twenty-eight rows, equal; postmental plate transversely divided.............................. ......*E callicephalus* Boc.

When the limbs are appressed to the sides the feet are separated by the length of the posterior foot. Back brown. The lateral and median stripes are bordered with black from above the axillæ forwards. The black unites on the head, which is of that color above, below the lateral black it is yellow. Sides and lower surface of body and tail, blue.

Length of head and body to vent, M. .054; of head to auricular meatus, .009; width of head at do, .007. Length of posterior limb, .016; of anterior do., .011

CELESTUS CHALYBÆUS Cope, Proceeds. Academy Philada., 1866, p. 321.

This species differs from the *C. steindachneri* Cope, in having two prefrenals, one above the other. There is but one, an elevated prefrenal, in the latter species. Both have two postnasals* one above the other. In *D. chalybæus* the limbs are shorter, not meeting when appressed, by the length of the hind leg In *D. steindachneri* they are only separated by the length of the posterior foot. The latter species is well figured by Bocourt in the Miss. Sci. de Mexique.

Besides the specimen of the *D chalybæus* from Jalapa, the Smithsonian Institution has received the type from Orizaba from Sumichrast, and a second specimen from West Tehuantepec from the same naturalist.

SCELOPORUS ÆNEUS Wiegm. Uniform leek green above. From the stomach of a *Eutænia scalaris*.

SCELOPORUS MICROLEPIDOTUS Wiegm. From the stomach of a *Crotalus triseriatus*.

CATOSTOMA SEMIDOLIATUM D. & B.

*In my diagnosis of the *C steindachneri*, Proceeds. Acad. Phila., 1868, p. 128, the word postnasal is misprinted frontal.

EUTÆNIA SCALARIS Cope.

NINIA DIADEMATA Bd. Gird.

CROTALUS TRISERIATUS Wiegm. *Crotalus lugubris* Jan. For the character and synonymy of this species, see the third division of this paper.

III. NOTES ON CENTRAL AMERICAN AND MEXICAN BATRACHIA AND REPTILIA.

Cæciliidæ.

The species of this family, which have been described from the above region, are as follows I now place them in the genera of this family as defined by Professor Peters in the Monatsberichte Akademie, Berlin, 1879, p. 930 .

GYMNOPIS OLIGOZONA. *Siphonops oligozonus* Cope.

Hab.?

GYMNOPIS SIMA. *Siphonops simus* Cope.

Costa Rica, *Von Franzius.*

GYMNOPIS PROXIMA *Siphonops proximus* Cope

Costa Rica, *Gabb.*

GYMNOPIS MULTIPLICATA Peters.

Veragua

DERMOPHIS MEXICANUS. *Siphonops mexicanus* Dum. Bibr.

Tehuantepec, *Sumichrast;* Tobasco, *Laszlo.*

DERMOPHIS SYNTREMUS *Siphonops syntremus* Cope. I refer this species here provisionally only, as I have not been able to find the type specimen.

Belize.

HERPELE OCHROCEPHALA *Cæcilia ochrocephala* Cope.

Panama, *Gallær*, *Bransford*

CÆCILIA ISTHMICA Cope.

East side of Darien, *Selfridge.*

Anguidæ.

BARISSIA FIMBRIATA Cope. *Gerrhonotus auritus* "Cope," Bocourt, Mission Scientif Mexique, Reptiles, p. 337, Pl. xxi, fig. 2, xxi A, 7, 7a, not of Cope.

This species, which is handsomely figured by Bocourt, is not the species I described as *Gerrhonotus auritus*, but is a new species of Barissia It agrees with the *B. antauges* Cope in having three pairs of supranasal plates instead of the two pairs of the other species. Its ear processes and other characters distinguish it from *B. antauges.*

Teidæ.

VERTICARIA HEDRACANTHA. *Amiva hedracantha* Bocourt, Miss. Sci. Mexique, Rept, p. 263.

The third species of this genus.

Colubridæ.

LEPTOGNATHUS TORQUATUS Cope. *Dipsadomorus fasciatus* Bocourt, Bulletin Soc Philomathique, Paris, 1884, March; nec *Leptognathus fasciatus* s. *Tropidodipsas fasciata* Gunther, 1868.

LEPTOGNATHUS SARTORII Cope, 1863 *Leptognathus sexscutatus* Bocourt, Bulletin Soc. Philomathique, Paris, 1884, March.

Hab. Guatemala, *Bocourt*; Vera Cruz, *Sartorius*.

MESOPELTIS MULTIFASCIATUS. *Leptognathus multifasciatus* Jan. M.S. Bocourt, Bullet. Soc. Philomathique, Paris, March, 1884. *Asthenognathus* Bocourt.

The genus Asthenognathus Boc., 1884, appears to be identical with Mesopeltis Cope, 1866

EUTÆNIA INSIGNIARUM, sp. nov.

Scales in twenty-one rows, all keeled except inferior row, which sometimes presents short keels at the bases of the scales Superior labials eight, eye over fourth and fifth Three postoculars. Temporals 1–2. Lateral band on the third and fourth rows of scales. No dorsal band, but the dorsal region yellower than the sides for a width of from four to six scales. A row of black spots above the lateral stripe, which are sometimes divided so as to form two rows one above the other. A row of incomplete black spots below the lateral line, which are formed by the adjacent black edges of three or four scales. A black spot on each side behind the angle of the mouth, which extend upwards to near the occipital shields, and is preceded by a light spot of half crescentic form. The last superior labial and temporals in front of this space, have black edges. Superior labials slightly black-edged. No spots on the parietal plates. Gastrosteges, 164; urosteges, 68 to 74. Total length of a rather small specimen, M .435; of tail, .096, to canthus oris, .014.

I took the typical specimen of this species from a bunch of herbage which grew from the wall of the aqueduct at the castle of Chapultepec near the city of Mexico. Professor Herrera, director of the Escuela Preparatoria of the city of Mexico, showed me a living specimen which was taken near the city, and gave me a third, preserved in spirits. M. Bocourt sent a specimen to the Smithsonian Institution, and Dr Dugés gave me a fifth, which was taken near Guanajuato.

This species is nearest to the *E. flavilabris*. I give comparative diagnoses of these two, together with that of a third species which is related to both, which I obtained on the upper waters of the Gila river in New Mexico.

First row of scales smooth or nearly so; tail shorter, urosteges, 68–74; no dorsal stripe nor occipital spots .... *E insignarum.*

First row of scales smooth; tail shorter, urosteges 71; a dorsal stripe and occipital spots. .... *E flavilabris.*

First row of scales keeled, tail longer, one fourth of total, urosteges, 84; a dorsal stripe and occipital spots .... *E. megalops.**

EUTÆNIA CHRYSOCEPHALA, sp nov

The discrimination of this species will be facilitated by comparing it with other species of the genus, which occur in Mexico and Central America, in which the lateral stripe is on the second and third rows of scales.

I. Scales in seventeen rows.

Inferior row keeled, urosteges, 81, no dorsal stripe; a large black nuchal spot, head yellow. .... *E. chrysocephala.*

II. Scales in nineteen rows

Lower row of scales keeled, urosteges, 91, a dorsal stripe, lateral stripe not defined below; gastrosteges not black at the base, a large nuchal spot; head brown.............................. *E. collaris* Jan.

Lower row of scales smooth; urosteges, 67; a dorsal stripe; lateral stripe bordered below by a brown stripe; a black nuchal spot; head brown.. *E. pulchrilatus*

Urosteges, 60–65; no stripes, but four rows of small spots which do not touch each other, but become larger on the neck; a large oblique black band on each side the nape; head brown; keels very strong... *E. sumichrasti.*

The *Eutænia cyrtopsis* of Kennicott belongs to this group, and comes nearest to the *E. collaris* Jan. In fact, the second variety of the *E. cyrtopsis*, described by Kennicott (Proc Acad. Philada., 1860, p. 334), is the *E collaris* Jan. The latter is a common species in Mexico. I have it from Guanajuato, *Dugès*, Orizaba, *Sumichrast*, from the valley of Toluca, *Vasquez*, and from Guatemala from *Dr Van Patten* I do not find the gastrostega to exceed 153 in number, while Kennicott gives 179 as the number in his types from Coahuila. I therefore keep the species apart, although I shall endeavor to verify the number given by Kennicott on his types.

The *E chrysocephala* has a slender body, and a wide, flat head, with a large eye. The size of the latter contracts the frontal plate, so that it is not wider than the superciliaries posteriorly. The scuta are otherwise as usual Superior labials eight, none higher than long, fourth and fifth below orbit. The inferior surfaces are darker than in *E. collaris*, which causes a better definition of the lateral line than in that species. There are representations of two rows of lateral black spots, but they are merely

* *Eutænia megalops* Kenn. Proceeds. Acad. Phila, 1860, p. 330. My specimen is from Duck creek, a tributary of the Gila. Gastrosteges 164, total length, M. .610, tail, .158. Color above brown, a few scales black-edged near the stripes. A postoral crescent, black-edged behind.

black scale-borders, those of the inferior row the more distinct A similar row of black edges on the first row of scales. All of these spots become distinct on the sides of the neck Nuchal spot large, black, and with a shallow notch behind; no occipital or other spots on the head. The gastrosteges have black bases, a character not seen in any of the other species here referred to.

Gastrosteges, 151. Total length, M .430; of tail, .135, or one-third the total.

This handsome species was obtained at Orizaba, Vera Cruz, by Dr. Sumichrast.

EUTÆNIA PULCHRILATUS, sp. nov.

At first sight this species looks like the *E. flavilabris* Cope, but it has characters of the *E. collaris*, and adds some of its own.

The dorsal stripe, as in *E. collaris*, occupies but a single row of scales. The lateral stripe, occupies the adjacent edges of the second and third rows. The entire front row is covered by a broad brown band, which defines the lateral light band very distinctly below. This is not seen in either of the species above named There are two rows of black spots between the dorsal and lateral bands, but the keels of all the scales involved in them are brown There are no spots below the lateral light line, either on the neck or elsewhere. A large nuchal black spot, which is notched behind by the median band. No postoral crescent. Head above brown; lower surfaces uniform greenish, except tail, which is yellowish below. Occipital spots very indistinct.

The head is not very distinct from the neck. The frontal plate is wider than the supraorbitals. Gastrosteges, 158, urosteges, 67. Total length, M. .465; of tail, .105.

One specimen from Dr Dugés; locality uncertain, but probably Guanajuato.

EUTÆNIA SUMICHRASTI Cope. Proceedings Acad. Philada., 1866, p. 306.

To the description already given, I add some notes taken from a third specimen. The frontal plate is wider than the supraorbitals. There are eight superior labials, and the orbit is bounded by the fourth and fifth. Temporals, 1–2; orbitals, 1–3. There is a trace of a dorsal stripe on the nape, which divides the nuchal spot in two. No postoral crescent. Below the square lateral spots on the sides of the neck is a row of smaller, alternating square spots, which serve to define a lateral stripe for a short distance. Superior labials brownish yellow, brown edged Inferior surfaces uniform dirty yellow.

The keels of the scales are very strong, except those of the first row, which are obsolete. Gastrosteges, 148, urosteges, 65. Total length, M. .265, length of tail, .065, or one-fourth the total

The locality whence the typical specimens of this species were obtained is Orizaba, Vera Cruz. The locality of a third specimen is uncertain. It

may be the plateau of Costa Rico at Cartago, from Dr. Van Patten's collection. If this indication be correct, this is the most southern species of the genus.

STORERIA TROPICA, sp nov.

This species agrees with the *S dekayi* Holbr, excepting in two points. It has but six superior labials The diminution in the number is posterior to the orbit, and the fifth and sixth scuta are of a different form from those of the *S. dekayi* They are longer and less elevated. The second character is in the color. This species lacks the dark mark that descends from the orbit to the superior labial margin in the *S. dekayi.*

Peten Guatemala, *H Hague.*

COLUBER MUTABILIS, sp nov. *Coluber triaspis* Cope, Proceeds. Amer. Philos, Soc, 1879, p 271, nec Copei.

Two species of this genus are already known from Mexico, the *C. flavirufus* and *C triaspis* Cope, which are distinguished by various peculiarities both of scutellation and of color A considerable number of specimens have, however, been received by the Smithsonian Institution, which present intermediate characters On study it appears that these really represent a species distinct from either, and one which inhabits the elevated regions of the country, while those previously known belong to the Tierra Caliente. I distinguish the species as follows:

Scales in 27–9 rows, one loreal; nine superior labials; three rows of temporal scuta between labials and occipital, dorsal and lateral spots large and close together, an oblique light band on post-temporal region, and a narrow yellow median spot on nape, marks not becoming obsolete......... ... . *C. flavirufus.*

Scales in 31–3 rows; one loreal, eight upper labials; three rows of temporal scuta, dorsal and lateral spots smaller, and separated; three longitudinal bands behind frontal region, all the markings becoming obsolete in a general brown color, with maturity....... *C. mutabilis*

Scales in 35 rows; two or three loreals, eight upper labials, four rows of temporals; dorsal and lateral spots smaller, separated, three longitudinal black bands from frontal region to nape, ? maturity. *C. triaspis.*

Of the *Coluber mutabilis* I have before me four specimens from Vera Paz from Mr Hague; one from the plateau of Costa Rica from Mr. Zeledon, and one from the central or elevated part of the State of Tehuantepec, from Mr. Sumichrast. I have examined a seventh specimen in the collection of Professor Alfredo Dugés, who took it in the State of Guanajuato. Of the *C flavirufus,* there are three specimens before me; the type from Tobasco, *Berendt;* one from Vera Cruz from Sartorius, and one from Yucatan from the Schott collection of the Commision Cientifica. I have examined two large specimens in the city of Mexico brought from the State of Chiapas, from Dr. R Montes-de-Oca.

Slight variations sometimes occur in the *C. mutabilis*. One specimen has 35 rows of scales; another has but two rows of temporals on one side; another has nine superior labials on one side.

The head is long and rather narrow The prefrontals are, each, longer than wide, the frontal is not narrowed; the parietals are truncate behind The suture between the loreal and the prefrontal is oblique, running posteriorly downwards, so that its superior border is only half as long as the inferior. The preocular does not reach the frontal. There are, as in the other Mexican species of the genus, but two postoculars The eye is over the fourth and fifth labial. None of the labials behind the fifth is elevated, but the sixth is elongate so as to border the ends of the three long temporal scuta. The inferior of these covers the seventh and part of the eighth labials, and supports above it two others like it, all being directed downwards and forwards The superior encloses little scale with the superior postocular. Inferior labials, eleven; geneials well developed, the posterior smaller and separated by scales.

In a young specimen 450 mm. in length, where the color markings have not become obsolete, there are 76 dorsal spots, of which 51 are between the nape and the vent. These spots are transversely quadrate, covering 11 scales transversely, and two and a half scales anteroposteriorly. They are dark brown with light edges, and paler centers. The interspaces are less than two scales long The lateral spots are opposite the intervals and are in one row; they are subround or suboval. There are two brown stripes on the nape which, instead of uniting at both ends, as is the case in the *C. flavirufus*, are separate posteriorly and diverge anteriorly, extending to above the posterior part of the orbits. Between them another band occupies the middle line, but is more or less broken. A broad brown band convex forwards between the fronts of the orbits A brown spot behind orbit. Below immaculate.

Gastrosteges, 282; anal double, urosteges, 109. Total length, M. 1.090; of tail, .235 mm

The typical specimen is from Vera Paz; No. 6735 Mus. Smithsonian.

MANOLEPIS NASUTUS. *Tomodon nasutus* Cope, Proceedings Academy Philadelphia, 1864, p. 166.

This species cannot enter Tomodon D & B., because it has a divided anal plate, and no scale-fossæ, though it agrees with that genus in its single nasal plate and smooth scales. I therefore propose the genus Manolepis to embrace it and similar species.

HYDROCALAMUS QUINQUEVITTATUS. *Homalopsis quinquevittatus* Dum. Bibr. Erp. Gen. vii, p 975. *Calopisma quinquevittatus* Jan. Elencos Sistematico, p. 75. *Hydrops lubricus* Cope. Proceeds. Acad. Phila., 1871, p. 217.

Vera Paz, *Dum. Bibr.*; E. Tehuantepec, *Streets*.

Duméril and Bibron put this species quite out of its place, so that I did not perceive it in my *Hydrops lubricus*. It requires a new generic desig-

nation, which I give above. It is allied to Dimades, Abastor, etc., but differs from them all in having a grooved posterior maxillary tooth. The characters of the genus Hydrocalamus are:

Opisthoglyph. Two internasal and two prefrontal plates. Two nasals, a loreal, and one preocular. Anal scutum divided Scales smooth.

The genus differs from the nearest opisthoglyph calamarians as follows. From Elapomorphus and Scolecophis in the divided anal scutum, and from the former in its two nasals. from Procinura in the absence of the rugosities of the caudal scales.

LIMNOPHIS SEPTEMVITTATUS. *Calopisma septemvittata* Fischer, Verhandl. Naturwiss. Verein, Hamburg, 1879, p. 84, Pl i, f 3.

This species agrees exactly with Limnophis Gunther in scutellation, and approaches very nearly in dentition. It is not referable to any other genus now named.

TRIMETOPON GRACILE. *Ablabes gracilis* Gunther. Ann Magaz. Nat. Hist, 1872, p 18. From Costa Rica, Gunther

The characters of the genus Trimetopon are as follows:

Two internasals, one prefrontal plate Two nasals, rostral not produced, a loreal and one preocular Scales smooth, with one pore. Anal divided

There are three other aglyphodont calamariform genera, with one prefrontal plate. From Colorhogia Cope, Trimetopon differs in having two nasal plates; from Opisthotropis Gunth, in having smooth scales; and from Chersodromus R. & L., in the presence of a preocular plate, and in the smooth scales

GYALOPIUM PUBLIUM Cope. American Naturalist, 1884, p. 168 *Ficimia publia* Cope, Proceeds. Acad Phila, 1866, p 126. *Ficimia ornata* Bocourt, Miss. Sci. Mexique, 571, Pl. xxv, f. 10.

Hab. Yucatan, *Schott.*

GEAGRAS REDIMITUS Cope. Journal Acad Philada., 1875, p 141. *Sphenocalamus lineolatus* Fischer, Oster Programm des Akad. Gymnas., Hamburg, 1883, p. 5, Pl. i, figs 3–5.

Tehuantepec, *Sumichrast;* Mazatlan, *Fischer*

GEAGRAS FRONTALIS Cope. Journal Academy Philada., 1875, p. 142. *Toluca frontalis* Cope. Proceeds Acad. Phila., 1864, p. 147 *Pseudoficimia pulchra* Bocourt. Miss. Sci Mexique, 572, Pl. xxxv, f. 12.

Colima, *Xantus;* Guadalaxara, *Major.*

GEAGRAS SUMICHRASTI Bocourt. Cope, Amer. Naturalist, 1884, p. 162. *Enulius sumichrasti* Bocourt. Miss Sci. Mexique, 538, Pl. xxxi, f 6

W Tehuantepec, *Sumichrast.*

GEAGRAS LONGICAUDATUS Cope. Amer Naturalist, 1884, p. 162 *Enulius murinus* Cope, Bocourt, Miss. Sci. Mexique, p. 537, Pl. xxxv, f. 9, nec Copei.

West Tehuantepec, *Sumichrast.*

LEPTOCALAMUS UNICOLOR. *Geophis unicolor* Fischer. Abhandl. d. Naturwiss. Vereins, Bremen, 1881, p. 227.

This species is allied to those of the genus Catostoma, but Fischer remarks that it has an elongate posterior maxillary tooth, or a syncranterian dentition This requires its separation from Catostoma, and its location in another genus, as indeed is remarked by Fischer, *l c.* This has been already established by Gunther for another species

RHEGNOPS ZEBRINUS Jan. *Rhabdosoma zebrinus* Jan Bocourt, Miss. Scient Mexique, Pl xxxiv, fig 1

This and another species are separated by Bocourt from the genus Catostoma (*Geophis*) on account of the divided anal scutum. He applies to this genus the name Rhabdosoma Dum Bibr. Unfortunately there is not a species of that genus, as enumerated by Duméril and Bibron, which possesses this kind of an anal scutum, and they must all be referred to Catostoma, of which the name Rhabdosoma is a synonym. Meanwhile in the year 1866,* I proposed for a species having the characters of Bocourt's Rhabdosoma, the name Rhegnops This genus differs from Carphophiops in the two nasal plates, and the single pair of geneials. The type is *R visoninus* Cope, *l. c.*, from Honduras.

CONTIA MICHOACANENSIS Dugés MS.

Muzzle moderately prominent, rounded, eye moderate, body cylindric; tail short, acute at end, not slender Scales without fossæ.

Rostral plate much wider than high. Internasal small Frontal large, longer than wide, posterior angle obtuse Superciliaries moderate, much narrowed anteriorly. Parietals as long as the frontal, rounded posteriorly The single nasal is narrow and is obliquely placed, being in contact by its posterior border with both the prefrontal and loreal, and not touching the second superior labial Loreal longer than high Preocular touching prefrontal and third superior labial. Two postocular, the inferior resting on the fourth and fifth superior labials Temporals 1–2 Seven superior labials, the third and fourth entering the orbit, the sixth very small. Six inferior labials, of which four are in contact with the geneials; postgeneials one-third the length of the pregeneials. Between the former and the gastrosteges, seven rows of small scales Scales in fifteen rows. Gastrosteges, 152; anal divided, urosteges, 37.

Length of head and body, M 0.160, of tail, .035; diameter at middle of body, 005.

Ground color probably red in life; in alcohol it is a clear yellow. A large black spot covers the frontal, and the superciliaries, less their anterior extremities, surrounds the eye, and terminates on the loreal, and the corresponding superior labials. It extends also on the antero internal angles of the parietals. Another black spot forms a wide collar interrupted on the median line below Then follow thirteen transverse rings, each oc-

* Proceeds. Academy, Philada., p 128.

cupying five or six rows of scales on the back, narrowing below, where some of them are interrupted Two of the rings are so wide as to lead to the belief that each of them consists of two rings united, so that the whole number is sixteen. Tail unspotted. The third, fifth, seventh and ninth interspaces from the head have the scales black-tipped, and are wider than the black bands. The skin has an elegant clear blue reflection.

From the state of Michoacan, Dr. A Dugés

Crotalidæ

CROTALUS POLYSTICTUS Cope Proceeds Acad. Philada, 1865, p. 191. *Crotalus triseriatus* Wagl. Jan Iconographie des Ophidiens, nec Wagleri. *Crotalus ximenesii* Dugés, Naturaleza, Mexico, 1877, p. 23, pl. i, figs. 18–20

Table land of Mexico.

I give the comparative characters of this species, and of the allied *C. triseriatus* of Wiegmann. I think that Professor Jan has transposed the name of that species to this one. I took a full description of the Crotali in the museum of Munich, from which apparently Wagler drew up his description (Naturliches Syst d. Amphibien, 1830, p. 176), and none of them belong to the present species. My notes made in Berlin, which I visited immediately afterwards, state that the specimens labeled *C. triseriatus* in the museum of the University, where Wiegmann worked, are like those of Munich

The *C triseriatus* varies more than the *C polystictus*. My descriptions are drawn up from five specimens of the latter, and six specimens of the former.

Two loreal plates, one above the other. Four internasals and four prefrontals, all longer than wide ; three rows of interorbital scuta and scales. Infraorbital scales in two rows of equal size Four elongate distinct brown spots behind occipital region , a narrow yellow band across frontal region. A large brown spot below orbit, and one below maxillary fossa Five rows of *large* dorsal spots Scales in twenty-seven rows , labial scuta fourteen ; subcaudal scutella 18 and 19. Generally of larger size

One of the five specimens above mentioned has twenty-five rows of scales

The specimens all come either from Guanajuato (Dugés), or from the valley of Mexico (Herrera).

CROTALUS TRISERIATUS. *Uropsophus triseriatus* Wiegm Wagler Nat Syst. Amphib , 1830, p. 176 *Crotalus lugubris* Jan. Prodrome d'un Iconogr. Revue et Mag. de Zoologie, 1859, p. 31, Pl E. Dugés' Naturaleza, Mexico, 1877, p. 25

One loreal plate ; two internasals and four prefrontals, wider than long, or the latter, square. Three or four rows of interorbital plates and scales. Two rows of infraorbital scales, of which the superior is very small. Colors plainer. Two post occipital spots ; no frontal band ; no infra-

orbital or infrafossal spots. One row of *large* dorsal spots. Twenty-three rows of scales, superior labial scuta 11–12, subcaudal scutella 22–29.

There are usually two rows of small spots on each side of the large dorsal series, and sometimes the latter breaks more or less into two rows. In a specimen from Guanajuato (Dugés), the dorsal spots continue into the small lateral spots, forming lateral cross-bands as in *Crotalus enyo.* In a specimen from the valley of Toluca, the lateral spots are obsolete, and there are 25 rows of scales The anterior part of the superior preocular is cut off to form a second loreal behind the usual one

The *Crotalus intermedius* of Fischer is near this species, but has several peculiarities according to Fischer, which may distinguish it.

Hab. Guanajuato, Dugés; Jalapa, *Flohr;* Toluca, *Vasquez*

CROTALUS BASILISCUS Cope Proceeds. Academy Phila., 1864, p. 66.
Crotalus rhombifer Latreille, Dugés La Naturaleza, Mexico, 1877, p. 22.

This species, originally discovered by Xantus at Colima, is generally distributed in Mexico. I have not seen it from east of the plateau. Dugés has obtained it at Guanajuato.

IV. ARUBA, LEEWARD ISLANDS, Julien.

The present collection was made by Prof. A A. Julien, of Columbia College, New York Aruba is the westernmost of the series of islands which lie in the Caribbean sea along the north coast of South America Its position is but a short distance to the eastward of the mouth of the Gulf of Venezuela. Its position gives its fauna considerable interest. The birds brought by Professor Julien, have been already reported on in papers published by the New York Academy of Sciences, by my friend, George N. Lawrence

1. PALUDICOLA BRACHYOPS Cope.
2. GONIODACTYLUS ALBOGULARIS D. & B
3. GONIODACTYLUS VITTATUS Wiegm
4. PHYLLODACTYLUS JULIENI, sp nov

This species is nearly related to the *P tuberculosus* Wiegm., but may be distinguished by three characters First, the abdominal scuta are less numerous, forming about thirty transverse series between axilla and groin; while those of *P. tuberculosus* are in at least forty cross rows. Second, the dorsal tubercles form uninterrupted longitudinal series, no small scales intervening between those of one row; although small scales separate those of different rows. Third, there are three scuta behind the mental. In most specimens of the *P. tuberculosus* there are two, in one only I find three. There are five narrow, straight blackish cross-bands between the axilla and groin; one in the front of the arms, and one across the nape, a brown band posterior to the eye. These markings become obsolete in the

largest specimens. The legs are light brown with pale spots, marks which are most distinct in adults. When the limbs are appressed to the side, the elbow marks the middle of the longest posterior toes.

The characters of this species may be well understood by comparing it with other species of the genus as follows.

I. Tubercles larger and more numerous, keeled

Abdominal scales in 30 transverse and 17 longitudinal rows, two postmentals and four scales behind them ....*P. ventralis* O'Sh.

Longitudinal series uninterrupted; abdominal scales in 30 transverse, and 21 longitudinal rows; 3 postmentals and six scales in the row behind them.......................................*P. julieni* Cope.

Longitudinal series interrupted by scales; abdominal scales in 40 transverse and 25 longitudinal rows..............*P. tuberculosus* Wieg.

II. Tubercles fewer, smaller and not keeled.

Tubercles in rows; abdominal scales in 56 rows, three postmental scuta; discs larger.......................................*P. galapagoensis* Pet.

Tubercles in rows; abdominal scuta in 56 rows; four postmentals; discs very small.......................................*P. microphyllus* Cope.

Tubercles not in rows, more obscure; abdominal scuta in 50 rows; two or three postmentals, discs larger; cross-banded.....*P. inæqualis* Cope.

The abnominal scales are in more numerous longitudinal rows than described in the allied *P. ventralis* O'Shaughnessy* of Jamaica, and the postmental plates and scutes have quite a different arrangement. The six scales of the first row form a series very convex backwards. Several specimens.

THECADACTYLUS RAPICAUDA Houtt.

TRETIOSCINCUS BIFASCIATUS Dum

CNEMIDOPHORUS MURINUS D & B.

AMIVA BIFRONTATA Cope. This species is now well known to be a New Grenadian species, and not to be found in the Virgin islands as was originally suspected.

IGUANA TUBERCULATA Laur

ANOLIS LINEATUS Daudin. Two specimens which only differ from the description of Duméril and Bibron in having the muzzle a little longer or the nostril a little posterior. The latter is separated from the rostral plate by two scales, instead of one, as described by Duméril and Bibron. These authors give Martinique as the habitat as indicated by a label.

V. CURACAO; U. S. Fish Commission.

A jar of reptiles from the above island, obtained by the naturalists of the U S. Fish Commission, was submitted to me by Professor S. F Baird, director. Curacao, as is known, is one of the same group as Aruba, and

* Annals and Mag. Nat. His., Oct., 1875.

the determination of its fauna is a point of considerable interest Unfortunately the number of species taken is small The names are as follows.

CNEMIDOPHORUS MURINUS D and B. Specimens as large as the *Amiva surinamensis*, No 13,860

GONIODACTYLUS ALBOGULARIS D. and B. No. 13,859.

Var. I. Four specimens. A pale dorsal band bounded on each side with a row of brown spots; two rows of blackish spots on each side; belly unspotted, throat faintly lined

Var. II One specimen. Brown above with a blackish collar pale edged behind, which sends forwards a brown band to the eye. Above this a short brown band from eye. Lips and throat with some brown speckles

Var. III. One specimen Brown above, a blue-black band along lips to shoulder. A short blue black inguinal longitudinal band; below dusky, except throat, which is very pale, but with faint lines spreading on each side from a pale median band.

VI. NICARAGUA; Moser.

A small collection was sent to the National Museum by Lieut. J. F. Moser, U S. N. It contains the following species:

DENDROBATES TINCTORIUS Schneid. No. 13,736.

DENDROBATES TYPOGRAPHUS Keferst No. 13,738.

AGALYCHNIS HELENÆ Cope, sp. nov.

Head large and wide, muzzle short. Long diameter of eye a little less than length of muzzle in front of it measured obliquely, or one-third longer than muzzle measured axially, and entering width between anterior canthi of eyes one and one-half times. Nostril nearly terminal, canthus nostralis distinct concave The tympanic membrane is not distinct, and is a sub-vertical oval, two-thirds the long diameter of the eye. Inferior palpebra with oblique sub-parallel white veins. The vomerine teeth are in short series directed inwards and backwards from the anterior inner angle of the large choanæ Ostia pharyngea half as large as choanæ. Tongue large, wide and openly emarginate behind. The inner toes of both anterior and posterior feet are not opposable, and are furnished with well developed discs. Both are shorter than the adjacent second digit respectively The fingers are one-fourth webbed, and the toes one-third webbed. The heel of the extended leg reaches the end of the muzzle; the closed leg marks the end of the third toe with the knee. The width at the sacrum is but a little more than half that of the head posteriorly. Skin smooth above everywhere. Length of head and body, M .030, width of head posteriorly, .0115. Length of extended fore limb, .018, of extended hind limb, 042 Of the latter, the foot measures .0175, of which the tarsus is 0085.

The heel and the elbow present a dermal thickening at the apex; the inside of the elbow joint is also shortly webbed.

The color in spirits is greenish cream color; probably representing green, yellow and purplish in life. The same color covers the external faces of

fore-arm, tibia, tarsus, and fifth posterior toe, and a narrow band on the upper surface of the femur. The humerus, with the concealed surfaces of the limbs, and a well defined band from axilla to groin are dark purplish, which is only interrupted by five vertical narrow yellow bands, which cross the lateral band, and join a yellow border which bounds its superior edge. Toes and lower surfaces, yellow, deeper on the abdomen

This very pretty tree frog is most nearly allied to the *Agalychnis callidryas* Cope, a species which has been found both in Panama and in Vera Cruz It differs in the dark color of the concealed surfaces, and in the shorter, wider head, and in the smaller tympanic membrane. No. 13,737.

HYLA PUMA, sp. nov. Size of *H. carolinensis.*

Fingers with rudiment of web between external digits, toes half webbed Vomerine teeth in transverse patches, whose edges are in line of the posterior border of the posterior nares, Ostia pharyngea one-third as large as choanæ Tongue subround, nearly entire Tympanic membrane distinct, an oblique oval, its long diameter two-thirds that of eye fissure. Canthus rostralis well marked, concave, nostril nearly terminal, separated from orbit by a space equal long diameter of tympanum. Heel reaching middle of lores. Head rather small, muzzle short. Belly areolate, all superior surfaces smooth. Digital dilatations equal half diameter of tympanic disc. Color, above, uniform dark brown ; below, uniform light brown.

Total length, M. 045 ; of head from posterior line of tympana, axial, .015 ; width of do. at posterior line of tympana, .018 ; length of posterior limb, .071 ; of posterior foot, 031 ; of tarsus, .017 ; of anterior limb, .028, of anterior foot, 013.

This species is near to the *H phæota* Cope of the Darien region, and the *H. pulchella* D. and B. of Southern Brazil In the former the head is larger in proportion to the body, and the hind limbs are rather longer The color includes cross bands on back and limbs, and posterior to eye, all of which are wanting from *H puma.* The *H pulchella* has much the same proportions, etc., but has longer hind limbs, and a different coloration, especially a very distinct lateral band. No 13,735. One specimen.

CORYTHOPHANES MEXICANUS Wagler. No 13,745

ANOLIS BRANSFORDI Cope. Proceeds. Academy Phila., 1874, 67. No. 13,739.

PLIOCERCUS DIMIDIATUS Cope. A specimen with seventeen black annuli on the body, with the scales of the light interspaces black-tipped. In the type there are fourteen annuli, and the light-colored scales are not black-tipped. No 13,741

DRYMOBIUS BODDÆRTI Seetzen. No 13,743

TRETANORHINUS NIGROLUTEUS Cope. No. 13,744.

The nasal plates of this specimen do not meet in front of the internasals as described in the type specimen, otherwise they agree

BOTHRIOPSIS BRACHYSTOMA Cope. No 13,742

VII. Upper Beni River, Bolivia, Heath.

The collection described below, was made by Dr. Edwin R Heath during his explorations of the Upper Beni river in Bolivia. The country through which Mr. Heath passed had not been previously examined by any naturalist, hence considerable interest attaches to this collection.

Dermophis crassus, sp. nov.

The most robust species of the genus. Tentacular fossa near to but distinct from the eye, half way between canthus oris and nostril. Annuli 95, all complete except the first, which is not complete above, the third and fourth not complete below, and 94th and 95th, which are incomplete above. General form depressed. Width of head at first fold, equal length from same point. Length, mm. 423; width, 22 mm. or $\frac{1}{19\frac{1}{4}}$. Color black above and below; the plicæ when opened, white within.

The number of plicæ is smaller than in any other species, and the form is more robust. Two specimens, besides a third from Eastern Peru, obtained by Professor Jas Orton.

Mabuia agilis Raddi.

Diploglossus fasciatus Fitz.

Amphisbæna beniénsis, sp. nov.

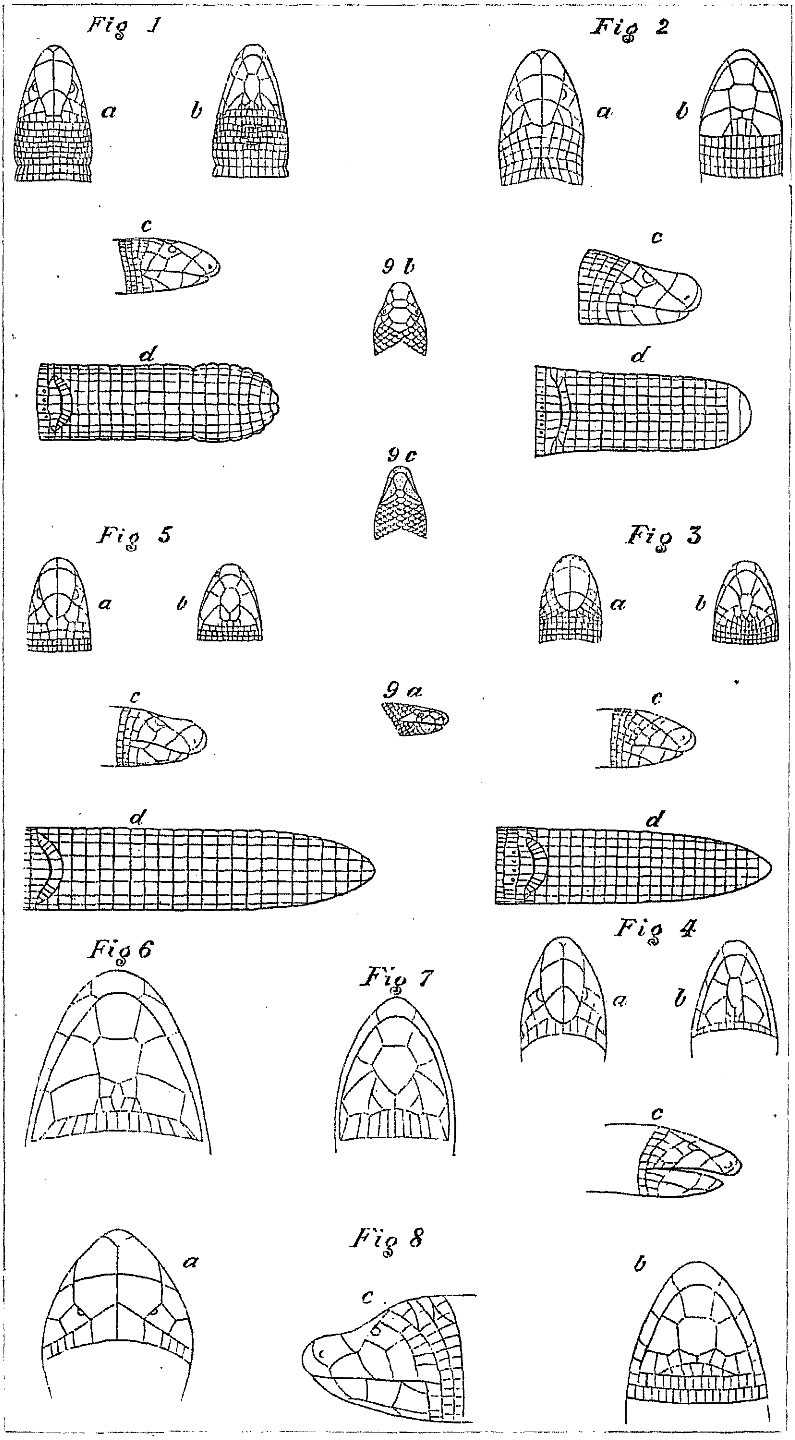
Of the group to which *A. pretrei*, *A vermicularis*, *A angustifrons* and *A. occidentalis* belong. Muzzle moderately elongate, obtuse, rostral plate a little visible from above. Nasofrontals broader than long, with nearly straight borders. Prefrontals longer than wide, with the posterior angle a little less than right. Frontals small; forming together a pentagon, each bounded posteriorly by a single small square parietal. One diamond-shaped ocular, showing the eye indistinctly in its anterior angle Labials $\frac{4}{4}$; the last one above and last two below, small; the latter pair not strongly separated. First superior labial longer than high, second higher than long; third longer than high, and separated from the ocular by a larger scute. Symphyseal scute subquadrate and truncate behind, bounded laterally by the first inferior labial only. Postsymphyseal nearly square, bounded laterally by the second inferior labial only. It is followed by two square scuta, each of which is bounded laterally by a large plate, which bounds the third inferior labial below.

Tail with sixteen annuli; preanal plates eight, or if the full extent of the fissure be considered, by ten plates. Preanal pores six. Total length 335 mm.; of head to canthus oris, 012; of tail, .025 M Color above, light reddish brown; below yellow.

The scutellation of the head of this species distinguishes it from all the species named The tail is as short as in the *A. angustifrons* Cope (Proceed. Acad. Philada., 1861, p. 76). See below, in synopsis of Amphisbæna.

Apophis conirostris Gunth.

A variety in which the dark, transverse dorsal marks are interrupted on



Figs. 1—8, Amphisbænidæ. Fig. 9, Anelytropsis papillosus.

the middle line, and are not always continuous, and are pale-bordered in front, and with a series of black spots below the lateral pale band. The light color below is red in life.

OPHEOMORPHUS MELEAGRIS Shaw *var.* SEMILINEATUS Cope. Proc. Acad Phila., 1860, 252. *Liophis meremmii* D. & B., var.

OPHEOMORPHUS TYPHLUS Linn.

CYCLAGRAS GIGAS D and B.; *Xenodon gigas* Dum. Bibr.; *Lejosophis gigas* Jan.

This species, with the *Liophis bicinctus* Dum. Bibr., belongs to a genus distinct from both Liophis and Xenodon. Its characters are: Dentition diacranterian; anal acute, entire; a circle of scales, with the superciliary surrounding the eye; scales smooth. Professor Jan has already distinguished the genus, but has given it a name (Lejosophis) which, when properly spelled (Liophis), is one which has already been used. I, therefore, give it another name, as above.

XENODON SEVERUS L.

OXYRRHOPUS SEBÆ D. & B.

PHILODRYAS VIRIDISSIMUS L.

LEPTOPHIS MARGINATUS Cope.

VIII. RIO GRANDE DO SUL, BRAZIL; H. Smith.

The Naturalist Brazilian Exploring Expedition, under the direction of Mr. Herbert H. Smith, commenced its work in the province of Rio Grande do Sul. The principal collections were made at Sao Joao do Monte Negro The present catalogue shows that the snake-fauna is not poor, and it adds some important points in the history of the geographical distribution of the Batrachia and Reptilia of South America. A number of the species in the collection are sent for the first time to the United States.

BATRACHIA.

BUFO DORBIGNYI Dum. Bibr.

BUFO MARINUS Linn.

ENGYSTOMA OVALE Schneid.

HYLA VAUTERII Dum. Bibr.

HYLA PULCHELLA Dum. Bibr.

The normal coloration is presented by numerous specimens. Another one is brown, with three darker, brown dorsal bands, a median narrow one and two lateral wider ones, with indistinct superior margins above the light border of the lateral brown band. The hind-legs are also cross-banded, a character not found in the normal form.

PALUDICOLA RANINA, sp nov

Metatarsal tubercles, two ; minute. A subround inguinal gland Skin of back with delicate folds, viz , a straight dorsolateral and a median pair, which approach each other above the scapulæ, then diverge, then approach in front of the sacrum, and then diverge and disappear. Numerous short plicæ and narrow warts on each side of the coccyx ; superior surfaces of posterior legs with smaller warts. Toes slender, free, with narrow dermal margins. Abdomen with a circular fold Form of head and body rather elongate, legs not long, feet long ; heel of extended hind leg reaching to middle of orbit. Tympanic disc faint or invisible, forming a vertical oval, whose long diameter is a little more than half that of the eye-fissure. The muzzle is acuminate, and is a little longer than the long diameter of the eye. The profile descends to the end of the muzzle, which is narrowed, but not prominent Nostrils nearly terminal Tongue pyriform, entire. When the fore limb is extended, the wrist reaches the end of the muzzle. First finger shorter than second , third quite long

Length of head and body, M. 028 ; of head to posterior line of tympana, .009 , width of head at the same, .0095 , length of fore limb, .018 ; of fore-foot, .008 ; of hind limb, .045 ; of hind foot, .017.

The color varies from brown to gray above. A black band passes from the orbit to the level of the abdomen, its abdominal border extending from the axilla three-quarters way to groin A black line on inferior edge of canthus rostralis Lip from this band to the postorbital band, with numerous light-brown striæ extending downwards and backwards Inguinal gland with a round black spot, with some pale-brown lines concentric to it in front and below. A brown band between superciliary edges, and a T-shaped brown mark on top of muzzle. Middle line between dermal plicæ brown, generally with a pale brown spot at their point of expansion. A light-brown band extends from this brown space posteriorly and downwards on each side. Other brown shades on the lateral dorsal region In some of the specimens some of these markings of the upper surfaces are wanting. Below straw color, thickly speckled with reddish-brown everywhere, excepting on the posterior abdominal and subanal regions. Legs with brown cross-band, with narrow pale edges, two on the tibia, very oblique. Concealed posterior face of femur, brown with pale speckles.

This species is apparently abundant at Sao Joao do Rio Negro. The smaller specimens are often darker colored, have more numerous dorsal plicæ, and have four dorsal, brown, longitudinal bands It agrees with the genus Paludicola as I have defined it (under the name of Gomphobates R & L), in the absence of frontoparietal fontanelle, the non-union of the prefrontal bones, and the osseous xiphisternum with narrow bifurcate cartilage.

In my estimation, Mr Boulenger has united two, and perhaps four, genera, in his revision of Paludicola (Catal. Batr. Salientia, Brit. Mus., 1882, p. 229). I have distinguished these genera as follows :

I A frontoparietal fontanelle.

Inguinal glands....................................*Pleurodema.*

No inguinal glands....................................*Luperus.*

II Frontoparietal bones ossified.

Inguinal glands....................................*Paludicola.*

M Boulenger has shown that the genera established on the degree of development of the metatarsal shovels are not tenable.

LEPTODACTYLUS OCELLATUS Linn.

LEPTODACTYLUS MYSTACINUS Burm.

PSEUDIS PARADOXA Laur

Reptilia.

ANOPS KINGII Bell.

The genera of the Amphisbaenidæ, besides the Lepidosterninæ, are the following, as they appear to me :

I The nasal plates lateral, separated from each other on the median line.

a. Nasals separated by the rostral.

Rostral with a median cutting edge, extending between the frontonasals ; *Anops* Bell.

Rostral flat, not extending between frontonasals.........*Diphalus** Cope.

aa. Nasals separated by the frontonasals.

Frontonasals united into one plate ; no frontals.............*Blanus* Wagl.

Frontonasals united ; frontals present.......................*Cadea* Gray.

II. The nasal plates in contact with each other on the median line.

a. Preanal pores present.

Nasal plates distinct. ....*Amphisbæna* Linn.

"Nasal plates united" Gray.........................*Typhloblanus* Fitz.

Nasals, frontonasals and anterior labials united ... ...*Ophioproctes* Boul.

aa. No preanal pores.

Nasal plates distinct ....*Aporarchus* Cope.

AMPHISBÆNA TRACHURA, sp nov.

Before giving the detailed characters of this species, I will compare all the true Amphisbænæ of which I can obtain information. With extended explorations this number has so increased, that new definitions are needed

I. No supraorbital plates (*Amphisbæna*).

A. A preorbital plate.

A suborbital plate ; caudal rings 26 ; anal pores 8. *A suborbularis* Peters

A suborbital ; caudal rings 24 ; anal pores 4........*A. mildei* Peters.

No suborbital plate , 4 superior labials, last largest ; 3 inferiors, first very large ; a large temporal on each side.......*A. kraussi* Peters.

* Type *Diphalus fenestratus* Cope. Proc Acad. Phila., 1861, p. 76; *Amphisbæna antillensis* R. & L

AA No preorbital plate.

a. No suborbital plate.

β. Symphyseal plates wide as, or wider than long

Four superior labials, caudal rings 17. . . . . *A. alba* L.

ββ. Symphyseal plate longer than wide

Superior labials 4, head short, wide, tail smooth; above spotted yellow and brown. . . . . *A. occidentalis* Cope.

Superior labials 3, head acute, tail smooth; uniform above. *A. darwini* D. & B.

Superior labials 3, head acute, tail conical, with 18 rings; several terminal rings very distinct and divided into prominent hard tubercles; color uniform above . . . . *A. trachura* Cope.

aa. A suborbital plate.

β. Two small labials below suborbital.

Four superior labials, symphyseal and postsymphyseal narrow; caudal rings 17, smooth . . . . *A. angustifrons* Cope.

ββ. One large labial below suborbital.

Superior labials 4, tail smooth, with sixteen rings, symphyseal and postsymphyseal plates square; unicolor above. . . . . *A beniensis* Cope.

Superior labials 3; tail smooth with 26–8 annuli; unicolor above. *A pretrei* D. & B.

aaa. Two suborbital plates

Superior labials 3, symphyseal and postsymphyseal plates square; tail with 29–33 smooth annuli; spotted above . . . . *A fuliginosa* Linn.

II. A supraorbital plate; two frontonasals.

a. No preorbital (*Zygaspis* Cope).

Several pairs of parietals and temporals; inferior labials 4. *A. quadrifrons* Peters.

III. A supraorbital and preorbital plates; frontonasals united. *Cynisca* Gray.

One pair of parietals and temporals; inferior labials 3. . *A. leucura* D. & B.

The *Amphisbæna vermicularis* D. & B. probably enters the above synopsis near to the *A. darwini*, but I cannot learn all of its characters. It is distinct from all the species of Division I, in having a more slender body with more numerous annuli, viz, 232, according to Duméril and Bibron. I cannot now give the characters of the *A. camura* Cope, as the specimens are mislaid.

In general appearance the *Amphisbæna trachura* is a good deal like the *A. pretrei* as figured in the zoology of Castelnau's journey in South America. It also resembles in general the *A. angustifrons* from Buenos Ayres. The head is elongate and the muzzle decurved and prominent. The rostral plate is just visible from above. The frontonasals are each longer than wide. The frontals form an oval which is just as wide as long. The third superior labial reaches the ocular, and the row behind these two plates consists of four scales to the frontal. Inferior labials

three. Symphyseal is broadly truncate behind. The postsymphyseal (geneial) is a longitudinal oval, and each side is equally divided between the first and second labial and the postgeneial. The latter is separated from the second and third labials by a triangular scute. Preanal pores four; preanal scuta eight, the median much longer fore and aft Annuli, 196 on the body, and 18 on the tail. The latter is compressed at the extremity so that the tip is a vertical oval. The last half dozen grooves are deep and the scales are represented by semi-globular bosses, as in the genus Rhineura

Total length, M. .315; of head to canthus oris, .0095, of tail, .030.

Color above, lead color, with a mulberry shade; below, light yellowish.

APORARCHUS PRUNICOLOR, gen et sp. nov.

The genus has been defined in the key under the head of the species *Anops kingii* It is simply Amphisbæna without preanal pores.

The only specimen on which the species rests is of smaller size than those which represent the species enumerated in the above table, excepting the *A. occidentalis*, which is the smallest of the genus

Rostral plate scarcely visible from above; common suture of nasals short, nasofrontals each as long as broad; frontals each longer than broad; a pair of well distinguished square parietals. Labial, 3–3, the third reaching the ocular, so that there is no subocular No superciliary or preorbital plate. Three plates in the row from canthus oris to frontal plate. Symphyseal broader than long, truncate posteriorly; postsymphyseal broad as long, subcircular, each half bounded by the postgeneial, and first and second labials to an extent represented by the order of mention. Last inferior labial twice as long as deep. Annuli 186 on the body and 23 on the tail. Preanal scales eight, the row preceded by a groove which is wider than the others. Tail obtuse, caudal annuli entirely smooth

Total length, M. .214, of head to canthus oris, .006; of tail, .029.

Color, uniform plum-color above and below, excepting the lower jaw, chin and part of pectoral region and a postanal crescent, which are white: All the grooves of the inferior surface are white also, so that the animal has a latticed appearance below.

PANTODACTYLUS BIVITTATUS Cope. Proceeds Academy Philada., 1863, p. 103.

ACRANTUS VIRIDIS Merr. Numerous specimens.

TEJUS TEQUEXIN Linn.

OPHEODES STRIATUS Wagler.

PHALOTRIS MELANOPLEURUS, sp. nov.

The genus *Elapomorphus* of Wiegmann, as defined by Duméril and Bibron, was divided by me in 1863 into three genera, one of which retained the original name, and the other two received the names of Phalotris and Apostolepis. Numerous species have been since added to

the genus, and the new species falling readily into the division I proposed, confirm its propriety. Those with two internasal and two prefrontal plates are true Elapomorphi They are *E blumii* Wiegm , *E. wuchereri* Gthr , *E lepidus* Rhdt., and *E mexicanus* Gthr. The genus Apostolepis has distinct prefrontal plates but no internasals. The species are . *A. d'orbignyi* D. & B ; *A flavotorquatus* D. & B. , *A. erythronotus* Peters; and *A assimilis* Rhdt. In Phalotris there are two internasals, but only one prefrontal The species are . *P. tricolor* D. & B.; *P bilineatus* D. & B. , *P lemniscatus* D. & B., and the subject of the present description

Scales in different longitudinal rows, all rather short and wide. Muzzle narrow ; rostral plate prominent, forming more than a semidisk in outline. Internasals quite small, nearly triangular. Prefrontal wider than long, not reaching labials Frontal large, its parietal border as long as its superciliary. Parietals elongate, their median suture considerably exceeding length of frontal plate Nasal elongate behind nostril, touching the preocular, which is longer than high; two small postoculars. Temporals 1-1, the anterior very narrow in one specimen, just reaching, and in another not reaching, inferior postocular. Superior labials six, second and third in orbit. Inferior labials seven, fourth and fifth very large, first in contact with its mate of the other side Geneials well developed, posterior pair equal to anterior. Gastrosteges, 211, anal double; urosteges, 25. Tail acute.

Color black everywhere, except a wide red dorsal band covering five and two half rows of scales In one specimen this band is divided on the median row of scales by a black line ; in another specimen this line extends but a short way behind the nape. A yellow collar with a black posterior edge above. Sides of throat yellow, head black. The free edges of all the scuta, scutella and black scales, are white.

Total length, M 311; of head to canthus oris, .006; of tail, 025

OPHEOMORPHUS DORSALIS Peters. Monatsberichte Berlin Akademie, 1863, p. 283. Abundant.

OPHEOMORPHUS FUSCUS, sp. nov.

Scales in seventeen rows, all but those of five median rows as wide as, or wider than, long Muzzle moderately obtuse, internasals and prefrontal subquadrate; frontal and superciliary plates elongate; parietals moderate, bifurcate posteriorly Frontal narrowing posteriorly; posterior angle less than right Loreal higher than long. Preocular not reaching frontal; two postoculars, both in contact with the single temporal of the first row. Other temporals two, the superior long, leaving but two small ones for contact with the parietals behind, one of them being median. Eight superior labials, fourth and fifth entering orbit; sixth and seventh higher than long Inferior labials ten, sixth the largest and the last one in contact with the geneials. Postgeneial equal pregeneials. Gastrosteges, 182, anal divided; urosteges, 55.

Above olive or yellowish-brown, all the scales with a blackish border,

which is widest on the apex of the scale. Head above and on sides uniform brown, scuta in some specimens narrowly black-edged Below yellow, the scuta and scutella with narrow blackish edges, frequently imperfect on the middle of the former.

Total length of a median specimen, M. .695 ; of head to canthus oris, .019 , of tail, 112

This species is quite abundant at Sao Joao, and some of the specimens reach a larger size than the one measured. It is nearly allied to the *O. meleagris* Shaw, which is, to judge from the collection made, the most abundant snake at Sao Joao The latter always has nineteen rows of narrow scales, and the color is constantly different. The *O fuscus* never has the black band through the eye, nor the broad black borders and centres of the cephalic scuta, nor the ventral black spots and cross-bands of the *O. meleagris*. It never has the imperfect black dorsal spots and tail-bands characteristic of the variety *O m semilineatus*, which is the most abundant form at Sao Joao. Young specimens of the *O fuscus* agree exactly with the adult in color.

OPHEOMORPHUS MELEAGRIS Shaw. *Liophis merremii* Dum Bibron.

Principally represented by the Southern variety, *semilineatus* Cope (Proceedings Academy, Philadelphia, 1860, p 252). Very abundant The young of this form have the dorsal spots very distinct, which are feebly represented in the adult They run more or less together to form imperfect cross-bands, but mostly alternate on opposite sides of the middle line The top of the head is black.

With increasing age, then, this species becomes much lighter colored , yellowish and light bluish, taking the place of a great deal of black.

APOROPHIS CONIROSTRIS Gunther.

APOROPHIS CYANOPLEURUS, sp nov

The species of Aporophis (Cope, Proceeds. Amer. Philos Soc. 1877, p. 18, *Lygophis olim*, nec. Fitzingeri = *Philodryas*) are sometimes referred to Dromicus and sometimes to Liophis They may be readily distinguished from the latter genus by the absence of scale-fossæ (sometimes called scale pores), while they differ from Dromicus in the shorter tail. This portion represents a fourth or a little more of the total length in Aporophis, and a third or more in Dromicus It is quite possible that the groups may have to be united in one genus in future, but I have not yet met with intermediate forms. The species of Aporophis known to me are: *A conirostris* Gthr. ; *A lineatus* Linn ; *A. dilepis* Cope*, *A. flavifrenatus* Cope (= *Coronella pulchella* Jan.) , *A anomalus* Gthr (= *L. rutilus* Cope) ; *A. nicagus* Cope ; *A undulatus* Wied. (Dromicus Peters) , *A juliæ* Cope ; *A melanocephalus* Peters (*Dromicus melanocephalus*, Monatsber. Berl. Acad., 1863, 277 , dentition not described). Aporophis

* This species differs from *A. lineatus* in color, and not only in its two preocular plates, as supposed by Dr. Fischer.

only differs from Rhadinæa in its diacranterian dentition; a character which will probably prove to be not entirely constant

The present species is quite nearly allied to the *A. undulatus* of Wied. The scales are in seventeen rows, and those of the first row are longer than deep The rostral plate is transverse, and its apex visible from above. The internasal and prefrontal pair are wider than long. The frontal is elongate and with parallel sides, and its length exceeds that of the muzzle in front of it, and equals that of the common occipital suture. The occipital plates are long, equaling the width between the posterior exterior angles of the superciliary plates. The loreal plate is higher than long. The single preocular reaches the summit of the front, but not the frontal plate. Two postoculars, each deeper than wide. Temporals 1–2–3 Superior labials eight, eye resting on fourth and fifth; all longer than high, excepting the fifth. Inferior labials eight, fifth largest and in contact with postgeneials; all longer than deep. Postgeneials considerably longer than pregeneials. Total length, .805; length of head to rictus oris, .021; length of tail, .245. Gastrosteges, 150; urosteges, 88; anal divided.

Color above bluish olive, with a median dorsal brown band with ill-defined borders, of four scales in width. Sides, up to the front row of scales inclusive, dark slate blue, which forms a band from the canthus oris to the end of the tail, which extends also on the ends of the gastrosteges and urosteges. On the anterior third of the length in the larger specimen, and on the greater part of the body in the smaller, this part of the band isolates itself into dark round spots; on the upper edge of the lateral band every other scale has a pale spot in the centre. Head dark brown above. A black band passes through each eye from the end of the muzzle, and following the edge of the occipitals unites on the nape into a single median band which continues as the dorsal band. Belly yellow, gastrosteges bluish at the bases and edges, forming cross-lines.

TACHYMENIS HYPOCONIA Cope. Proceeds. Academy Phila., 1860, p. 247. *Mesotes obtrusus* Jan., Archiv. p. la Zoologia Modena, 1863, Coronellidæ, p. 96. Abundant.

THAMNODYNASTES NATTERERI Mikan. Abundant.

DRYMOBIUS PANTHERINUS Merrem.

HERPETODRYAS CARINATUS Linn.

PHILODRYAS SCHOTTII Fitz. Abundant.

PHILODRYAS OLFERSII Licht. Abundant.

TROPIDODRYAS ÆSTIVUS D. & B. *Dryophylax* D. & B.; *Philodryas* Günther.

The name Tropidodryas is proposed for a genus which differs from Philodryas only in having keeled scales. It includes the *T. æstivus* and the *T. serra* (*Dryophylax* D. & B.).

LEPTOGNATHUS CATESBYI D. & B.

OXYRRHOPUS RHOMBIFER D & B.

OXYRRHOPUS PLUMBEUS Wied.

LYSTROPHIS DORBIGNYI Dum. & Bibr. *Heterodon dorbignyi* Dum & Bibr.

The generic name Lystrophis is now proposed for the Heterodontes of Duméril and Bibron, which have smooth scales and a divided anal plate. Catachlein has been already proposed by Jan. for the smooth species with entire anal plate.

XENODON RHABDOCEPHALUS Boie.

XENODON NEOVIDII Gunth.

HELICOPS INFRATÆNIATUS Jan. Iconographie Ophidiens, Livr. 28, 1868. Pl. iii, fig. 3. *Helicops trivittatus* Cope Proceeds. Am. Philos Soc., 1877, p. 92.

One side of the head of the single specimen displays but seven superior labials; the other side eight. Both sides display two loreal plates, one above the other

HELICOPS BALIOGASTER, sp nov.

Scales in nineteen longitudinal rows; those of six rows on each side as wide as, or wider than long, all keeled except those of the first row on each side, the second very weakly. Dorsal scales finely striate. Head little distinct, muzzle very short. Nostrils superior. Each nasal plate and the loreal higher than long. Preocular very narrow, two postoculars, each longer than deep. Internasal small; prefrontals wider than long. Frontal long with parallel sides, occipital rather long Temporals 2—2, the superior of the anterior pair only reaching the postoculars, and in contact with both of them. Superior labials eight, the fourth only entering the orbit. Inferior labials eleven, seventh largest, and the last one in contact with the postgeneials, which are about as long as the pregeneials. Total length, M .587; of mouth to canthus, .017; of tail, .114. Gastrosteges, 128; one divided anal; scutella, 69.

Superior and lateral surfaces to the middle of the second row of scales blackish brown, with a lighter brown band on the sixth and adjacent halves of the fifth and seventh rows. A yellow lateral band on the adjacent halves of the first and second rows of scales. Belly black with one or two square yellow spots on the middle portions of most of the gastrosteges, which are sometimes so arranged as to leave a black spot in the middle, which together form parts of a median black band on the thoracic region. Tail with a median black band below. A dark cross-band connecting the corners of the mouth across the throat. In a young specimen this cross-band connects the ends of two longitudinal black stripes, which extend from each penultimate inferior labial. A black band on each side of the geneials connected by a cross-bar across the ends of the postgeneials. In the younger specimen the dark brown of the back is lighter, and each

dorsolateral brown band has a row of small dusky spots along its superior and inferior edges.

This species is near the *H infratæniatus* Jan., and future investigation may prove it to be a variety of that species In two specimens of the latter the scales are in seventeen rows, in three specimens of the *H. baliogaster* they are in nineteen rows In a small *H. infratæniatus* the external edges of the dorsal band are not spotted but form a dark band. The color of the lower surface in the two species is quite different.

I note here that the *Helicops alleni* Garman, from Florida, has the scales entirely smooth. It is necessary therefore that it be placed in another genus, which I call Liodytes. Its diagnosis is that of Helicops with the addition, scales smooth

ELAPS ALTIROSTRIS Cope. Three specimens

BOTHROPS ALTERNATUS D. & B. Common.

Explanation of Plate.

Heads and tails of Amphisbænidæ Fig *a* Head, from above, *b*, from below, *c*, from the side, *d*, the tail with preanal plates and pores, from below.

Fig. 1 *Amphisbæna trachura* Cope

Fig 2. *Amphisbæna beniensis* Cope.

Fig 3 *Amphisbæna occidentalis* Cope

Fig 4 *Amphisbæna angustifrons* Cope.

Fig 5 *Aporarchus prunicolor* Cope.

Fig 6. *Amphisbæna alba* Linn (Three specimens).

Fig 7 *A. alba* var *radiata* Cope. Caudal annuli 18; of the body 236, preanal plates 12; pores 8. Uniform white. Habitat unknown. One specimen

Fig 8 *A alba* var. *dissecta* Cope Annuli to vent 226; of tail 18; preanal plates 12, pores 8 Brownish above, below white. Venezuela. One specimen.

The Lineal Measures of the Semi-Civilized Nations of Mexico and Central America. By Daniel G. Brinton, M D.

(Read before the American Philosophical Society, January 2, 1885.)

Positive progress in constructive art can be accurately estimated by the kind and perfection of the instruments of precision employed by the artists. A correct theory of architecture or of sculpture must have as its foundation a correct system of weights and measures, and recognized units and standards of gravity and extension. Where these are not found, all is guesswork, and a more or less hap-hazard rule-of-thumb.

In a study of the art-products of Mexico and Central America, it has occurred to me that we may with advantage call linguistics to our aid, and attempt to ascertain, by our analysis of the words for weights and measures, what units, if any, were employed by those who constructed the massive works in that region, which still remain for our astonishment. The tongues I shall examine are the Maya of Yucatan, its related dialect, the Cakchiquel of Guatemala, and the Nahuatl or Aztec of Mexico. The most striking monuments of art in North America are found in the territories where these were spoken at the time of the conquest. The Cakchiquel may be considered to include the Quiche and the Tzutuhil, both of which are closely associated to it as dialects of the same mother tongue.

The Mayas.

The generic word in Maya for both measuring and weighing, and for measures and weights, is at present *ppiz*, the radical sense of which is "to put in order," "to arrange in definite limits." Its apparent similarity to the Spanish *pesar*, French *peser*, etc., seems accidental, as it is in Maya the root of various words meaning battle, to fight, etc., from the "order of battle" observed on such occasions. Any weight or measure is spoken of as *ppizib*, to measure land is *ppiz luum*, a foot measure *ppiz-oc*, etc. But I am quite certain that the original scope of the word did not include weight, as there is no evidence that the ancient Mayas knew anything about a system of estimating quantity by gravity. If the word is not from the Spanish *pesar*, it has extended its meaning since the conquest.

The Maya measures are derived directly, and almost exclusively from the human body, and largely from the hand and foot.

Oc, the foot; *chekoc*, the footstep, the joint or length of the foot as a measure of length. Other forms of the same are *chekel*, *chekeb*. *chekeb-oc*, *chek-oc*, and this abundance of synonyms would seem to show that the measure of a foot was very familiar and frequent. The verb is *chekoc* (*tah*, *té*), as in the phrase:

Chekocté y-otoch Ku
He measured by feet His house God.

i. e. He measured by feet the church. From this was distinguished—

Xakab, paces or strides, a word confined to the paces of man. The verb is *xakab* (*tah*, *té*), to step off, to measure by paces.

Quite a series of measures were recognized from the ground (or, as some say, from the point of the foot) to the upper portions of the body.

Hun cal coy u-xul (one to the neck of the ankle its-end), extending from the ground to the narrowest portion of the ankle.

Hun ppuloc u-xul (one calf-of-the-leg its-end), from the ground to the highest portion of the calf of the leg. The word *xul* means end or limit, and is used often adverbially, as in the phrase *uay u xul*, literally "here its end," or "thus far," (Span. *hasta aqui*).

Hun pixib, the distance from the ground (or point of the toes) to the knee-cap. From *piix*, the knee. Also called *hun hol piix*, from *hol*, head, the knee-cap being called "the knee-head."

Hun hachabex, one girdle, from the ground to the belt or girdle to which the skirt was fastened (from *hach*, to tie, to fasten). The same measure was called *hun theth*, the word *theth* being applied to the knot of the girdle.

Hun tanam, from the ground to the border of the true ribs, from *tanam*, the liver. The *Diccinario de Motul* gives the example, *hun tanam in ual*, one *tanam* (is) my corn, *i. e.*, my corn reaches to my chest. It adds that the measure is from the point of the foot to the chest.

Hun tzem, a measure from the ground to a line drawn from one mamma to the other.

Hun cal u-xul, one neck its-end, from the ground to the border (upper or lower?) of the neck.

Hun chi, from the mouth, *chi*, to the ground.

Hun holom, one head, from the top of the head to the ground. This is also called *hun uallah*, one time the stature or height of a man, from a root meaning "to draw to a point," "to finish off." The Spanish writers say that one *uallah* was equal to about three *varas*, and was used as a square measure in meting corn fields (*Dicc. Motul*). The Spanish *vara* differed as much as the English ell, and to the writer in question could not have represented quite two feet. Elsewhere he defines the *vara* as half a *braza* or fathom. (See below, *betan*.)

The hand in Maya is expressed by the word *kab*, which also means the arm, and is more correctly therefore translated

by the anatomical term "upper extremity." This is not an uncommon example in American tongues. When it is necessary to define the hand specifically the Mayas say *u cheel kab*, "the branch of the arm," and for the fingers *u nii kab*, "the points (literally, noses) of the arm" or upper extremity.

The shortest measurements known to them appear to have been finger-breadths, which are expressed by this phrase *u nii kab*. The thumb was called *u nā kab*, literally "the mother of the hand" or arm, and as a measure of length the distance from the first joint to the end of the nail was in use and designated by the same term.

With the hand open and the fingers extended, there were three different measures or spans recognized by the Mayas.

1. The *nāb*, from the tip of the thumb to the tip of the middle finger.

2. The *oeonab*, or little *nāb*, from the tip of the thumb to the tip of the index finger. This is the span yet most in use by the native inhabitants of Yucatan (Dr. Berendt).

3. The *chi nāb*, or the *nāb* which extends to the edge, from the tip of the thumb to the tip of the little finger (Pio Perez).

The *kok* was a hand measure formed by closing the fingers and extending the thumb. Measuring from the outer border of the hand to the end of the thumb, it would be about seven inches.

The *cuc* or *noch cuc* (*noch*, is a term applied to a bony prominence, in this instance to the olecranon) was the cubit, and was measured from the summit of the olecranon to the end of the fingers, about eighteen inches.

The most important of the longer measures was the *zap* or *zapal*. It was the distance between the extremities of the extended arms, and is usually put down at a fathom or six feet.

The half of it was called *betan* or *pātan*, meaning "to the middle of the chest." Canes and cords were cut of the fixed length of the *zap* and bore the name *zapalche*, *zap*-sticks, as our *yard-stick* (*che* = stick), and *hilppiz*, measuring rods (*hil*, a species of cane, and *ppiz*, to measure, *Dicc. Motul*).

On this as a unit, the customary land measure was based. It was the *kaan*, one shorter, *hun kaan tah ox zapalche*, a *kaan* of three *zap*, and one longer, *hun kaan tah can zapalche*, a *kaan* of four *zap*. The former is stated to be thirty-six fathoms

square, the latter forty-eight fathoms square. Twenty *'kaan* made a *vinic*, man, that amount of land being considered the area requisite to support one family in maize.

The uncertainty about this measure is increased by the evident error of Bishop Landa, or more probably his copyist, in making the *vinic* equal to 400 square feet, which even in the most favored soils would never support a family. He probably said "400 feet square," which in that climate would be sufficient. The *kaan* is said by Spanish writers to be equal to the Mexican *mecate*, which contains 5184 square feet. I acknowledge, however, that I have not reconciled all the statements reported by authors about these land measures.

Greater measures of length are rarely mentioned. Journeys were measured by *lub*, which the Spaniards translated "leagues," but by derivation it means "resting places," and I have not ascertained that it had a fixed length.

The Mayas were given to the drawing of maps, and the towns had the boundaries of their common lands laid out in definite lines. I have manuscripts, some dating as early as 1542, which describe these town lands. In most of them only the courses are given, but not the distances. In one, a title to a domain in Acanceh, there are distances given, but in a measure quite unknown to me, *sicina*, preceded by the numeral and its termination indicating measures, *hulucppiz sicina*, eleven sicinas.*

The maps indicate relative position only, and were evidently not designed by a scale, or laid off in proportion to distance. The distinguished Yucatecan antiquary, the Rev. Don Crescencio Carrillo, in his essay on the cartography of the ancient Mayas,† apparently came to the same conclusion, as he does not mention any method of measurement.

I do not know of any measurements undertaken in Yucatan to ascertain the metrical standard employed by the ancient architects. It is true that Dr. Augustus LePlongeon asserts positively that they knew and used *the metric system*, and that the metre and its divisions are the only dimensions that can be applied

* Acanceh Cheltun Titulo de un solar y Monte en Acanceh, 1767, MS.

† *Geografia Maya.* Anales del Museo Nacional de Mexico, Tomo ii, p. 435.

to the remains of the edifices.* But apart from the eccentricity of this statement, I do not see from Dr. LePlongeon's own measurements that the metre is in any sense a common divisor for them.

From the linguistic evidence, I incline to believe that the *oc*, the foot, was their chief lineal unit. This name was also applied to the seventh day of the series of twenty which made up the Maya month; and there may be some connection between these facts and the frequent recurrence of the number seven in the details of their edifices.†

The Cakchiquels.

The root-word for measuring length is, in Cakchiquel, *et.* Its primitive meaning is, a sign, a mark, a characteristic. From this root are derived the verbal *etah*, to measure length, to lay out a plan, to define limits; *etal*, a sign, mark, limit; *etabal*, measured field; *etamah*, to know, *i. e.*, to recognize the signs and characters of things; *etamanizah*, to cause to know, to teach, to instruct; etc.

My authorities do not furnish evidence that the Cakchiquels used the foot as a unit of measurement. differing in this from the Mayas. They had, however, like the latter, a series of measurements from the ground to certain points of the body, and they used a special terminal particle, *bem* (probably from *be*, to go), "up to" to indicate such measurements, as *vexibem*, up to the girdle (*vex*, girdle, *i*, connective, *bem*, up to, or "it goes to").

These body measures, as far as I have found them named, are as follows.

quequebem, from the ground to the knee.

ru-vach a, from the ground to the middle of the thigh; literally "its front, the thigh" (*ru*, its, *vach*, face, front, *a*, the muscles of the thigh).

vexibem, from the ground to the girdle, *vex*, which in ancient times supported the breech-cloth.

*"The metre is the *only measure of dimension* which agrees with that adopted by these most ancient artists and architects."—Dr Le Plongeon, *Mayapan and Maya Inscriptions*, in Proceedings of the American Antiquarian Society, April, 1881.

†"Nearly all the monuments of Yucatan bear evidence that the Mayas had a predilection for the number *seven*," etc. Le Plongeon, *Vestiges of the Mayas*, p. 63, (New York, 1881). Of course, this may have other symbolic meanings also.

qualqaxibem, from the ground to the first true ribs.

kulim, from the ground to the neck (*kul*).

The more exact Cakchiquel measures were derived from the upper extremity. The smallest was the finger breadth, and was spoken of as one, two, three, four fingers, *hun ca*, *cay ca*, *ox ca*, *cah ca* (*ca* = finger). This was used in connection with the measure called *tuvio*, the same that I have described as the Maya *kok*, obtained by closing the hand and extending the thumb. They combined these in such expressions as *ca tuvic rugin hun ca*, two *tuvics* with (plus) one finger breadth (Coto, *Diccionario*, MS.).

The span of the Cakchiquels was solely that obtained by extending the thumb and fingers and including the space between the extremities of the thumb and *middle* finger. It was called *qutu*, from the radical *qut*, which means to show, to make manifest, and is hence akin in meaning to the root *et*, mentioned above.

The cubit, *chumay*, was measured from the point of the elbow to the extremities of the fingers. We are expressly informed by Father Coto that this was a customary building measure. "When they build their houses they use this cubit to measure the length of the logs. They also measure ropes in the same manner, and say, *Tin chumaih retaxic rigam*, I lay out in cubits the rope with which I am to measure." (*Diccionario*, MS.)

The different measures drawn from the arms were:

chumay, from the elbow to the end of the fingers of the same hand.

hahmehl, from the elbow to the ends of the fingers of the opposite hand, the arms being outstretched.

telen, from the point of the shoulder of one side to the ends of the fingers of the outstretched arm on the other side.

tzam telen, from the point of the shoulder to the ends of the fingers of the same side. *Tzam* means nose, point, beak, etc.

ru vach qux, from the middle of the breast to the end of the outstretched hand.

hah, from the tips of the fingers of one hand to those of the other, the arms outstretched.

Another measure was from the point of the shoulder to the wrist.

The *hah*, or fathom, was one of the units of land measure, and the corn fields and cacao plantations were surveyed and laid out with ropes, *gam*, marked off in fathoms. The fields are described as of five ropes, ten ropes, etc., but I have not found how many fathoms each rope contained.

Another unit of land measure in frequent use was the *makoh*. This was the circumference of the human figure. A man stood erect, his feet together, and both arms extended. The end of a rope was placed under his feet and its slack passed over one hand, then on top of his head, then over the other hand, and finally brought to touch the beginning. This gives somewhat less than three times the height. This singular unit is described by both Varea and Coto as in common use by the natives.

There were no accurate measures of long distances. As among the Mayas, journeys were counted by resting places, called in Cakchiquel *uxlanibal*, literally "breathing places," from *uxla*, the breath, itself a derivative of the radical *ux*, to exist, to be, to live, the breath being taken as the most evident sign of life.

There was orignally no word in Cakchiquel meaning "to weigh," as in a balance, and therefore they adopted the Spanish *peso*, as *tin pesoih*, I weigh. Nor, although they constructed stone walls of considerable height, did they have any knowledge of the plumb line or plummet. The name they gave it even shows that they had no idea what its use was, as they called it "the piece of metal for fastening together," supposing it to be an aid in cementing the stone work, rather than in adjusting its lines (Coto, s. v. *Ploma de albañil*).

The Aztecs.

In turning to the Mexicans or Aztecs, some interesting problems present themselves. As far as I can judge by the Nahuatl language, measures drawn from the upper extremity were of secondary importance, and were not the bases of their metrical standards, and, as I shall show, this is borne out by a series of proofs from other directions.

The fingers, *mapilli*, appear to have been customary measures. They are mentioned in the early writers as one equal to an inch. The name *mapilli*, is a synthesis of *maitl*, hand, and *pilli*, child, offspring, addition, etc.

The span was called *miztetl* or *miztitl*, a word of obvious derivation, meaning "between the finger nails," from *iztetl*, finger nail. This span, however, was not like ours, from the extremity of the thumb to the extremity of the little finger, nor yet like that of the Cakchiquels, from the extremity of the thumb to that of the middle finger, but like that now in use among the Mayas (see above), from the extremity of the thumb to that of the index finger ("cuanto se mide con el pulgar y el indice." Molina, *Vocabulario*).

There were four measures from the point of the elbow; one to the wrist of the same arm, a second to the wrist of the opposite arm, a third to the ends of the fingers of the same arm, and the fourth to the ends of the fingers of the opposite arm, the arms always considered as extended at right angles to the body. The terms for these are given somewhat confusedly in my authorities, but I believe the following are correct:

1. From the elbow to the wrist of the same arm; *cemmatzotzopatzli*, "a little arm measure," from *ce*, a, one, *ma* from *maitl*, arm or hand, *tzotzoca*, small, inferior, *patzoa*, to make small, to diminish.

2. From the elbow to the wrist of the opposite arm, *cemmitl*, an arrow, a shaft, from *ce*, and *mitl*, arrow, this distance being the approved length of an arrow. We may compare the old English expression, a "cloth-yard shaft."

3. From the elbow to the ends of the fingers of the same arm, *cemmolicpitl*, one elbow, *ce*, one, *molicpitl* elbow. This is the cubit.

4. From the elbow to the ends of the fingers of the opposite arm.

The following were the arm measures:

cemacolli, from the tip of the shoulder to the end of the hand (*ce*, one, *maçoa*, to extend the arm).

cemmatl, from the tip of the fingers of one hand to those of the other. Although this word is apparently a synthesis of *ce*, one, *maitl*, arm, and means "one arm," it is uniformly rendered by the early writers *una braza*, a fathom.

cenyollotli, from the middle of the breast to the end of the fingers (*ce*, one, *yollotl*, breast).

It is known thut the Aztecs had a standard measure of length

which they employed in laying out grounds and constructing buildings. It was called the *octacatl*, but neither the derivation of this word, nor the exact length of the measure it represented has been positively ascertained. The first syllable, *oc*, it will be noticed, is the same as the Maya word for foot, and in Nahuatl *xocpalli* is "the sole of the foot." This was used as a measure by the decimal system, and there were in Nahuatl two separate and apparently original words to express a measure of ten foot lengths. One was:

matlaxocpallatamachiualoni, which formidable synthesis is analyzed as follows: *matla*, from *matlactli* ten, *xocpal*, from *xocpalli*, foot-soles, *tamachuia*, to measure (from *machiotl*, a sign, or mark, like the Cakchiquel *etal*), *l*, for *lo*, sign of the passive, *oni*, a verbal termination "equivalent to the Latin *bilis* or *dus*" (Carochi, *Arte de la Lengua Mexicana*, p. 123). Thus the word means that which is measurable by ten foot-lengths.

The second word was *matlacyxitlatamachiualoni.*

The composition of this is similar to the former, except that in the place of the perhaps foreign root *xoc*, foot, *yxitl*, foot, is used, which seems to have been the proper Nahuatl term.

As these words prove that the foot-length was one of the standards of the Aztecs, it remains to be seen whether they enlighten us as to the *octacatl*. I quote in connection an interesting passage by the native historian, Fernando de Alva Ixtlilxochitl in his *Historia Chichimeca*, published in Lord Kingsborough's great work on Mexico (Vol. ix, p. 242). Ixtlilxochitl is describing the vast communal dwelling built by the Tezcucan chieftain Nezahualcoyotl, capable of accomodating over two thousand persons. He writes: "These houses were in length from east to west four hundred and eleven and a half [native] measures, which reduced to our [Spanish] measures make twelve hundred and thirty-four and a half yards (*varas*), and in breadth from north to south three hundred and twenty-six measures, which are nine hundred and seventy-eight yards."

This passage has been analyzed by the learned antiquary Señor Orozco y Berra.* The native measure referred to by Ixtlilxochitl was that of Tezcuco, which was identical with that

* Orozco y Berra, *Historia Antigua y de la Conquista de Mexico*, Tomo i, pp. 557-8 (Mexico, 1880).

of Mexico. The yard was the *vara de Burgos*, which had been ordered to be adopted throughout the colony by an ordinance of the viceroy Antonio de Mendoza. This vara was in length 0.838 metre, and as according to the chronicler the native measure was just three times this ($411\frac{1}{2} \times 3 = 1234\frac{1}{2}$, and $326 \times 3 = 978$), it must have been 2.514 metre. This is equal in our measure to 9.842 feet, or, say, nine feet ten inches.

This would make the *octacatl* identical with those long-named ten-foot measures, which, as I have shown, were multiples of the length of the foot, as is proved by an analysis of their component words.

This result is as interesting as it is new, as it demonstrates that the metrical unit of ancient Mexico was the same as that of ancient Rome—the length of the foot-print

Some testimony of another kind may be brought to illustrate this point.

In 1864, the Mexican government appointed a commission to survey the celebrated ruins of Teotihuacan, under the care of Don Ramon Almaraz. At the suggestion of Señor Orozco this able engineer ran a number of lines of construction to determine what had been the metrical standard of the builders. His decision was that it was "about" met. 0.8, or, say, $31\frac{1}{2}$ inches.* This is very close to an even third of the *octacatl*, and would thus be a common division of lengths laid off by it.

I may here turn aside from my immediate topic to compare these metrical standards with that of the Mound-Builders of the Ohio valley.

In the *American Antiquarian*, April, 1881, Prof. W. J. McGee applied Mr. Petrie's arithmetical system of "inductive metrology" to a large number of measurements of mounds and earth-works in Iowa, with the result of ascertaining a common standard of 25.716 inches.

In 1883, Col. Charles Whittlesey, of Cleveland, analyzed eighty-seven measurements of Ohio earth-works by the method of even divisors and concluded that thirty inches was about the

* *Memoria de los Trabajos ejecutados por la comision scientifica de Pachuca en el año de* 1864, p. 357, quoted by Orozco Almaraz's words are not at all precise. "la unidad lineal, con pequeñas modificaciones, debió ser cosa de 0, m 8, ó cuatro palmos próximamente."

length, or was one of the multiples, of their metrical standard.*

Moreover, fifty-seven per cent of all the lines were divisible without remainder by ten feet. How much of this may have been owing to the tendency of hurried measurers to average on fives and tens, I cannot say, but leaving this out of the question, there is a probability that a ten foot-length rule was used by the "mound-builders" to lay out their works.

It may not be out of place to add a suggestion here as to the applicability of the methods of inductive metrology to American monuments. The proportions given above by Ixtlilxochitl, it will be noted, are strikingly irregular (411½, 326). Was this accident or design? Very likely the latter, based upon some superstitious or astrological motive. It is far from a solitary example. It recurs everywhere in the remarkable ruins of Mitla. "Careful attention," says Mr. Louis H. Aymé, "has been paid to make the whole asymmetrical. * * * This asymmetry of Mitla is not accidental, I am certain, but made designedly. M. Désiré Charnay tells me he has observed the same thing at Palenque." These examples should be a warning against placing implicit reliance on the mathematical procedures for obtaining the lineal standards of these forgotten nations.†

Whatever the lineal standard of the Aztecs may have been, we have ample evidence that it was widely recognized, very exact, and officially defined and protected. In the great market of Mexico, to which thousands flocked from the neighboring country (seventy thousand in a day, says Cortes, but we can cut this down one-half in allowance for the exaggeration of an enthusiast), there were regularly appointed government officers to examine the measures used by the merchants and compare them with the correct standard. Did they fall short, the measures were broken and the merchant severely punished as an enemy to the public weal.‡

* *The Metrical Standard of the Mound-Builders.* Reduced by the Method of Even Divisors. By Col. Chas Whittlesey (Cleveland, 1883).

† *Notes on Mitla*, in *Proceedings of the American Antiquarian Society*, April, 1882, p. 97

‡ See Herrera, *Decadas de Indias*, Dec ii, Lib. vii, cap xvi, and Dec iii, Lib. iv, cap. xvii "Castigaban mucho alque falseaba medidas, diciendo que era enemigo de todos i ladron publico," etc

The road-measures of the Aztecs was by the stops of the carriers, as we have seen was also the case in Guatemala. In Nahuatl these were called *neceuilli*, resting places, or *netlatolli*, sitting places; and distances were reckoned numerically by these, as one, two, three, etc., resting places. Although this seems a vague and inaccurate method, usage had attached comparatively definite ideas of distance to these terms. Father Duran tells us that along the highways there were posts or stones erected with marks upon them showing how many of these stops there were to the next market-towns—a sort of mile-stones, in fact. As the competition between the various markets was very active, each set up its own posts, giving its distance, and adding a curse on all who did not attend, or were led away by the superior attractions of its rivals!*

So far as I have learned, the lineal measures above mentioned were those applied to estimate superficies. In some of the plans of fields, etc., handed down, the size is marked by the native numerals on one side of the plan, which are understood to indicate the square measure of the included tract. The word in Nahuatl meaning to survey or measure lands is *tlalpoa*, literally "to count land," from *tlalli* land, *poa* to count.

The Aztecs were entirely ignorant of balances, scales or weights. Cortes says distinctly that when he visited the great market of Mexico, Tenochtitlan, he saw all articles sold by number and measure, and nothing by weight.† The historian, Herrera confirms this from other authorities, and adds that when grass or hay was sold, it was estimated by the length of a cord which could be passed around the bundle.‡

The plumb-line must have been unknown to the Mexicans, also. They called it *temetztepilolli*, "the piece of lead which is hung

*Habian terminos señalados de cuantas leguas habian de acudir à los mercados," etc. Diego Duran, *Historia de la Nueva España*, Vol. ii, pp. 215, 216. Both the terms in the text are translated *legua* in Molina's Vocabulary, so that it is probable that the resting places were something near two and a half to three miles apart.

†"Todo lo venden por cuenta y medida, excepto que fasta agora no se ha visto vender cosa alguna por peso." *Cartas y Relaciones de Hernan Cortes*, p. 105. (Ed. Gayangos.)

‡"Tenian medida para todas las cosas; hasta la ierva, que era tanta, quanta se podia atar con una cuerda de una braza por un tomin." Herrera, *Decadas de Indias*, Dec. ii, Lib. vii, cap. xvi. In another passage where this historian speaks of weights (Dec. iii, Lib. iv, cap. xvii), it is one of his not infrequent slips of the pen.

from on high," from *temetztli*, lead, and *piloa*, to fasten something high up. Lead was not unknown to the Aztecs before the conquest. They collected it in the Provinces of Tlachco and Itzmiquilpan, but did not esteem it of much value, and their first knowledge of it as a plummet must have been when they saw it in the hands of the Spaniards. Hence their knowledge of the instrument itself could not have been earlier.

The conclusions to which the above facts tend are as follows:

1. In the Maya system of lineal measures, foot, hand, and body measures were nearly equally prominent, but the foot unit was the customary standard.

2. In the Cakchiquel system hand and body measures were almost exclusively used, and of these, those of the hand prevailed.

3. In the Aztec system, body measurements were unimportant, hand and arm measures held a secondary position, while the foot measure was adopted as the official and obligatory standard both in commerce and architecture.

4. The Aztec terms for their lineal standard being apparently of Maya origin, suggest that their standard was derived from that nation.

5. Neither of the three nations was acquainted with a system of estimation by weight, nor with the use of the plumb-line, nor with an accurate measure of long distances.

An Experiment in Weather Forecast. By Pliny Earle Chase, LL.D.

(Read before the American Philosophical Society, Jan. 16, 1885.)

The class of '88, in Haverford College, have studied Chase's Elements of Meteorology, with a special view to the formation of trained habits of observation. They have acquired such skill in local weather forecast* that they undertook, early in December, to predict the probable regions of fair and stormy weather for all parts of the United States, on Christmas and New Year's days. The predictions were forwarded to Washington and submitted, through the courtesy of Gen. W. B. Hazen, Chief Signal

*The verifications, after two months' study, ranged between 74 and 90.3 per cent, the general average being 81.5 per cent.

Officer U. S A , to the Board of Indications, to asceitain the degree of accuracy

The following were the grounds of forecast·

1. The mechanical influence of solar and lunar tides on atmospheric currents, which has been tested by sixteen years' investigation and observations at Philadelphia and Haverford College. The normal tendency of tidal pressure, independent of friction, polar and equatorial currents and other disturbing influences, is from the East at syzygy, from the South at the following octant, from the West at quadrature, and from the North at the following octant, thus forming a lunar wind-rose, of a like character to Dove's solar wind-rose

2 The normal percentage of average lunar rainfall on the several days of the lunar month, as deduced from three years' observations of the Signal Service Sergeants (Proc Amer Phil Soc xiv, 416–8)

3. The Signal Service tables of the winds which are most likely, as well as of those which are least likely, to be followed by rain or snow in each region, during each month of the year.

I had previously stated (Elements of Meteorology, Part i, p. 95), that "a verification of lunar forecasts in five cases out of nine should be regarded as satisfactory. In favorable localities, if due regard is paid to "temporary local influences, predictions may often be made for a month "in advance, which will prove true in three cases out of four." The reports which were received from the Signal Office were examined in several different ways, the lowest mean verification of lunar influence for the two days being 59 per cent , while the highest was 100 per cent., as is shown by the following tests :

I. *Tests of Lunar Influence.*

α. The tri-daily bulletins of the Signal Service Bureau, show that in 13 of the 22 regions, or 59 1 per cent , there were such differences of barometric pressure between the two days of observation as should be produced by tidal influence, viz increased pressure when the normal currents are retarded, diminished pressure when they are accelerated

β. The normal relation of temperature to pressure (thermometer rising when barometer falls, and *vice versa*) was shown in 17 of the 22 regions or 77 per cent.

γ The tendency to partial reversal of surface currents by friction, in passing over the land, and consequent partial opposition of lunar influence,* was shown in 19 of the 22 regions, or 86 per cent.

δ. The rainfall on Christmas day was 1.07 times as great as that upon New Year's day The lunar normal ratio was 1 04. This represents a verification of 97 per cent.

ε. The influence of "favorable localities," independent of any regard to "temporary local influences," was shown in the Middle Atlantic States,

* Elements of Meteorol. Part i, pp 93–5, Par. 1, 8, Proc. Amer. Phil. Soc., xi, 113.

where the verification was 100 per cent, the weather at every station, on each of the days, being such as was foretold.

II. *Tests of Solar Influence.*

ζ. The special report of the Board of Indications, showed a verification of 70.7 per cent. for the fair forecasts and a rainfall, in amounts sufficient to be measured, in 25 per cent. of the regions for which stormy indications were foretold. The full significance of this test cannot be satisfactorily determined, because the normal proportion of stormy winds which bring actual rainfall has never been published.

η. The forecasts which were authorized by the Signal Service tables showed a verification of 1275 — 19 = 67.1 per cent. on Christmas day, and of 575 — 15 = 38.5 per cent. on New Year's Day, or a general mean of 1850 — 34 = 54.4 per cent. In three of the regions at the former date, and in seven at the latter, no forecasts were prescribed by the tables, the wind-deflecting tendencies being from doubtful azimuths. This test, like the foregoing, is affected by the uncertainty as to what constitutes a satisfactory verification of storm-forecasts which cover winds from one-half of the azimuths.

θ. As nearly as could be ascertained from the tri-daily reports, the stormy indications in the Signal Service tables were verified in 65 per cent. for the fair winds, and there was measurable precipitation after 43 per cent. of the stormy winds, the general mean verification being 60 per cent. This would indicate a verification, according to the preceding test, of 54.4 — 60 = 90.7 per cent.

ι. The ratio of lunar to solar monsoon influence, which was shown in tests α and η (59.1 — 54.4 = 1.086) agrees very nearly with the ratio which was shown by the winds at Haverford during the past year (545 — 514 = 1.06). Of 1059 observations, 545 were nearer the azimuth which represented the lunar tidal tendency and 514 nearer that which represented the solar monsoon influence, as given by Coffin (Winds of the Globe, p. 431). This degree of accordance seems to justify the belief that the subsidiary value of lunar normals would be found as great elsewhere as it is at Haverford, for detecting and coordinating the abnormal influences of equatorial or polar, cyclonic or anticyclonic, local or general currents.

III. *Tests at Haverford College for 1884.*

κ. Tidal acceleration of atmospheric currents was accompanied by low barometer, tidal retardation by high barometer.

λ. The percentage, both of stormy winds and of cloudiness, was greater in the lunar stormy cycles than in the fair cycles.

μ. Of the 120 days on which the lunar tidal tendencies were more stormy than fair, 54 were accompanied by measurable precipitation; on 32 other days there were winds from stormy directions; 11 others were

cloudy, and on 23 days no special evidence of stormy disturbance was recorded. This represents 81 per cent of verification by storm or stormy tendency, and 19 per cent. of failure.

ν. Of the 120 days on which the lunar tidal tendencies were more fair than stormy, 74 were fair; on 21 other days there were winds from fair directions, and on 25 days there was rain or snow with no special record of fair influence. This represents 62 per cent of complete verification, 17 per cent of partial verification, and 21 per cent. of failure.

ξ. Making allowance for one day's possible shifting of fair and stormy tendencies, by the acceleration of equatorial cyclonic currents, or the retardation of polar anticyclonic currents, 85 per cent. of the fair, 71 per cent. of the stormy, and 79 per cent of all the indications were completely verified. In this test no stormy verification was admitted in which there was not an actual measurable amount of rain or snow.

o. Of the winds from stormy quarters during the year, 63 per cent. were followed within 24 hours by measurable amounts of rain or snow. Of the winds from fair quarters, 72 per cent. were followed by fair weather for 24 hours, with no measurable amount of rain or snow. The mean verification of all the wind indications was 68 per cent.

π. The comparative value of forecasts, from lunar indications which might have been foretold years in advance, and from wind indications which are good only for a day in advance, was $45 \div 63 = 71.4$ per cent. for storm; $62 \div 72 = 86.1$ per cent for fair, $53 \div 68 = 77.9$ per cent. for all.

ρ. The percentage of verification for stormy indications was greatest in winter and least in summer

σ. The percentage of verification for fair indications was greatest in autumn, and least in winter. There were marked indications, however, of a tendency toward general maximum verification in summer.

τ. The percentage of total verification was greatest in winter, when the thermal disturbance of Moon's tidal action is least, and least in summer, when the thermal disturbance is greatest

υ. The percentage of verification, both for the fair and for the stormy indications, was greater in the equinoctial semester than in the solstitial

φ. The conflict of solar daily and monsoon influences with lunar monthly tidal influencés was shown in numerous cases of stormy anticyclonism and fair cyclonism which had been overlooked in the daily forecasts from Washington. Predominating solar influence accounted for 32 of the 46 abnormal days during the fair lunar tendencies, and 51 of the 66 abnormal days during the stormy lunar tendencies, or 74 per cent. of the whole.

It would be unwise to draw any positive conclusions from the results of a single experiment, or from observations for a single year at a single station, but there is certainly encouragement for continuing the line of investigation which is here indicated.

Note on Cosalite, Alaskaite and Beegerite. By George A. Koenig.

(Read before the American Philosophical Society, January 16, 1885)

The discovery of another rich vein of Bismuth silver ore in Ouray Co, Colorado, last spring, has developed new interest in the sulphobismuthite minerals The new discovery is called "Gladiator," and is situated, according to Mr Stockder, my correspondent, at the mouth of Poughkeepsie gulch into the Uncompaghre valley. The "Alaska" is situated at the head of this gulch, some six or eight miles above the Gladiator

My esteemed friend and colleague, Prof. F. A Genth, examined some specimens of the new find, whilst others awaited my return from Europe.

In connection with this investigation, Dr Genth also analyzed material from a specimen, which I had given him as "Alaskaite" from the Alaska mine. The results of his analysis did not agree with the composition of alaskaite, as found by me, but rather with cosalite. To make doubly sure, he kindly asked me to repeat the analysis with well selected material from the same specimen. I did so with the following result ·

Bi	=	43.54
Pb	=	26.77
Ag	=	1.35
Cu	=	8 78
Fe	=	0.52
Zn	=	trace
Sb	=	undet.
S	=	17.13
Insoluble	=	0 60
		98.69

Particles of chalcopyrite could not be excluded in picking It we deduct the iron, with a corresponding quantity of copper and sulphur as chalcopyrite, we have

Bi	=	43 54 . 210	=		0.2007
Pb	=	26.77 : 206.4	=	0.1298	
Ag	=	1.35 : 215 3	=	0 0065	
Cu	=	8 22 . 129 6	=	0 0673	
					0.2036
S	=	16 54 : 32	=		0 5169
(Pb, Ag_2, Cu_2) : Bi . S			=	1 01 . 1 . 2.57	

or $2\,RS + Bi_2\,S_3$ = Cosalite

Although I had used the same methods in the analysis of alaskaite, I felt induced to reexamine my type specimens of that species Upon closer examination the difference in color between this cosalite and the alaskaite becomes unmistakable. Still I might have been mistaken. The material was picked with much care, more than in my first examination, as will be seen by comparison of the results. It was scarce in conse-

quence, and one-half gram only was used for each analysis. Of one analysis all but the lead determination was lost

After separating Pb and Bi by dilute sulphuric acid and weighing the first as $PbSO_4$, the latter was dissolved in NaHO, and if a residue remained, it was dissolved in NHO_3 evaporated with dil. H_2SO_4, and thus a complete separation of Bi and Pb effected Bi was weighed as BiClO.

The spec gravity of 1 014 gr. was found = 6 782.

The analysis gave :

Bi	=	53 39	
Pb	=	12 02	(mean of 11.88 + 12 16)
Ag	=	7 80	
Cu	=	5.11	
Fe	=	0 84	
Zn	=	0.34	
S	=	17 98	
Sb	=	undet.	
Insoluble	=	1 80	
		99.16	

If we deduct again 0 84 Fe + 0 95 Cu + 0 94 S as chalcopyrite, we have as belonging to the light gray mineral .

Bi	=	53.39	210	=		0 2542
Pb	=	12 02 ·	206 4	=	0 0582	
Cu	=	4 16 :	129 6	=	0 0321	0.1317
Ag	=	7 80	215 3	=	0 0362	
Zn	=	0 34 .	64 9	=	0 0052	
S	=	17 04	32	=		0.5330

R . Bi S = 1 : 1.93 · 4 05

that is (Pb, Cu_2, Ag_2, Zn) S + Bi_2 S_3 = Alaskaite.

If the zinc be left out of the molecule, the ratio of 1 : 2 is perfect. It may be presumed therefore that the alaskaite is certainly a valid species, and that it occurs with cosalite at the Alaska mine From the latter species only the lighter gray color distinguishes it, but one must see the two together to notice the difference. The discovery of the cosalite at this mine we owe to Dr. Genth

Among the specimens, which I received through Mr Stockder of Lake City, from the "Old Lout" I noticed a very fine granular lead gray mineral which appears mixed with pyrite, chalcopyrite, barite and quartz I succeeded in getting 1 11 gr of it in a very fair degree of purity Its specific gravity, uncorrected, is 6 565. Its composition as follows :

Bi	=	19 35
Pb	=	45 87
Ag	=	9 98
Cu	=	1 12
Fe	=	2.89
S	=	16 39
Insoluble	=	0 12
		95.72

For the loss of 4 3 per cent in this analysis I can at present not account. Iron and copper eliminate themselves as chalcopyrite and pyrite, remain

Bi	=	19 35	210	=	0.0930	
Pb	=	45.87	206 4	=	0 2216	0.2878
Ag	=	9 98	215.3	=	0 0462	
S	=	13 37	32	=	0 4180	
R Bi S	=	3 09 . 1 . 4 5				

that is 6.18 $(PbAg_2)S + Bi_2S_3$ = Beegerite.

The original beegerite, crystallized, from Clear Creek county, Colorado, contains no silver at all Apparently this interesting species, only existing in one specimen heretofore, is not rare at the new locality, and may be procurable to collectors.

I reserve a more satisfactory examination to the future.

University of Pennsylvania, Jan., 1884.

The Remarkable Sun-glows in the Falls of 1883 and 1884.

By Wm. Blasius

(Read before the American Philosophical Society, January 16, 1885).

There has been much speculation by scientists as to the true explanation of those extraordinary sun-glows that astonished the world in November of 1883, and reappeared in a somewhat lesser degree at about the same time in 1884 In the attempt to explain the brilliancy of this phenomenon, some few meteorologists started on that philosophical principle, that it differs from the usual sun rises and sun-sets only in degree, and not in kind, and that an explanation must be found in the same laws that govern the ordinary phenomena, *i e*, in the refraction of the sun's rays in the stratum of moist air that surrounds the earth's surface.

These views found their difficulty in the fact that the atmosphere during the time the extraordinary phenomenon took place was comparatively dry, at any rate, that its moisture did not appear to reach to an altitude sufficiently elevated, to cause the glows to extend to that extraordinary height that they appeared to reach

To overcome this difficulty, some meteorologists brought the mysterious cyclone into play. The cyclone whirls, so they say, the moist air to an elevation sufficiently high to account for the phenomenon. If the position of the cyclone were such as to allow the sun's rays to pass, in its highest region, through only one side of it, the highest portion of the sun-glows might find a satisfactory explanation, but as it would be difficult for the sun's rays to pass through both sides of the cyclone, the lower portion of the sun-glows seems to be left unaccounted for.

When meteorologists failed to satisfactorily solve the problem, the astronomers took the case in hand, and looked for an adequate cause ex-

traneous to the atmosphere. Prof Young in Genf finds it in cosmic dust; Easterby ascribes the cause to chemical changes in the sun; others ascribe it to the influence of the aurora borealis or to the zodiacal light Lockyer considered that the volcanic ashes thrown into the air by the eruptions of the Krakatoa, in August, 1883, is the true cause, but I suppose he has changed his views by this time, as the phenomenon reappeared in 1884 without the recurrence of any eruption.

I will not enter into a criticism of these different views, but the general impression is that the phenomenon remains as much a puzzle as ever. This is perhaps not surprising, for so long as meteorologists continue to hold to the old theory, that the movements and changes of the air in the Temperate zone are of a cyclonic nature, so long they will be unable to satisfactorily explain most meteorological phenomena, and the brilliant sun-glows only add another to the list of failures.

Seen from a standpoint I believe I have found by a study of nature to be the true one, meteorological phenomena appear to the observer in a natural undistorted state, and they are easily understood and explained. The sun-glows and the ordinary sunset brilliancies, are caused by the same forces, but under different meteorological conditions, which cannot be understood so readily, when seen from the standpoint of the old cyclonic theory. In the one, as well as in the other case, the color is produced by the refraction of the sun's rays in a stratum or sheet of moist air. The surrounding stratum of moist air is often observed, especially during the time the sun rises and sets; therefore, the phenomena on a small scale take place frequently. The more magnificent phenomenon can only take place when, in the progress of the equatorial air current northward, the warm, moist current comes between the observer and the rising or setting sun. There is then going forward a displacement of the cold, dry polar current or wave, by the moist warm equatorial current or wave, the latter slanting obliquely up and over the polar air. Where these currents meet they lie in the position of two wedges, the polar current having the thin edge of its wedge toward the south, on the surface. The warm, moist equatorial current has the thin end of its wedge or sphenoid up and above the cold current toward the north; its progress is generally indicated by cirrus clouds, which in the further progress, change into cirro-stratus. If the observer is now situated in the polar current, he will find the temperature low, the barometer high, and the air comparatively dry, the wind coming from a northerly direction. Between him and the rising or setting sun he would encounter, if he ascended in a balloon, the equatorial current, a body of moist warm air in the shape of a sphenoid, or wedge, or a prism If there is a coincidence of the proper conditions, especially if the plane of meeting of the two currents has a tolerably steep inclination, the brilliant phenomenon as described will show itself.

For a more elaborate exposition of the relations of these equatorial and polar currents under such circumstances, I must refer to my work*.

"Storms, their nature, classification and laws, with the means of predicting them." (Porter & Coates, publishers) Especially to Plate vii, p 76, where will be found diagrams representing the north-east storm in its progress, *i e*, the warm moist southern current replacing the cold, dry northern current.

Let us now examine how these views agree with the actual state of the atmosphere on October 26, 1884, when this phenomenon last appeared. To this end I copy the record from the United States Signal Service record:

	7 A. M.	11 A. M.	3 P. M.	7 P. M	11 P M.	3 A M.
Barometer,	30597	30607	30560	30566	30556	30550
Temperature,	33 0	44	48 6	45 4	43 5	34 6
Dew point,	24.0	20	27 0	30 6	30 5	19.6
Humid.,	68	37	46	56	60	53
Dir. of wind,	N.	N.	S	S.E.	S E.	N.
Clouds,	0	0	0	Cir Cum.	0	0
	Clear.	Clear	Clear.	Cloudy.	Clear	Clear.

From this we see that the meteorological conditions of the atmosphere coincided favorably to show the phenomena in question to an observer in Philadelphia. High barometer, low temperature, clear weather, northerly wind At 3 P. M. the wind came from the south, then the temperature rose, the pressure decreased, and toward 7 P. M. Cir. Cum. appeared, indicating that the equatorial warm moist air, flowed obliquely over the polar current, and that it took a position between the observer in Philadelphia and the setting sun, and that the sun's rays of necessity went through the sphenoid or prism of the body of moist warm air, and so produced the brilliancy as described. Prof. Clement Hess,* from Frauenfeld, describes similar conditions in the atmosphere when the phenomenon took place in November 3, 1883, at his place of observation. The day preceding, all Europe was under high pressure, then came cirrus and cirro-stratus, with low pressure in their rear traveling eastward. Prof. Hess considers this low pressure a forward moving cyclone. Seen from my standpoint, it is the equatorial current lying in the form of a sphenoid above the polar current. The sun's position in relation to the inclination of the plane of meeting or the gradient, is evidently of much importance, and if we had all the facts, the result would be mathematically determined

If now it is asked why the brilliant sun-glows should not be observed every autumn, I think the answer is that it but infrequently happens that at this season of the year, when the sun is in position to produce this effect, the equatorial current reaches to sufficiently high altitudes And, it will be remembered, that both in 1883 and to a less degree in 1884, the approach of winter was exceptionally late, the equatorial current remaining much longer than usual in its summer position.

* Zeitschrift der Ostreichischen Gesellschaft für Meteorologie, xviii Band, p. 20.

A convenient Device to be applied to the Hand Compass.
By Persifor Frazer.

(Read before the American Philosophical Society, December 5, 1884.)

In the course of my professional work, it is very often necessary to make rapid recognizance surveys where absolute accuracy of detail is not necessary, and where superfluous equipage is to be avoided as much as possible. As a consequence those who have most experience with this kind of rough geological topography, following to the extent of their ability the example of its most distinguished expositor, Prof. J. P. Lesley, rely very largely upon determination of direction by the ordinary hand compass. This has many inconveniences, and is only possible of application by those who have had considerable experience. In the first place, there are no sights to direct the eye, nor any means to prevent the derangement of the needle, between the time that the sight is taken, and that when it is read off. Add to this the liability of the ordinary hand compass to be broken if its glass face be unprotected, or the cover lost, if this be of the ordinary unattached kind.

The difficulty alluded to last, had already been met, by the hunting case pocket compass which has been recently quite widely distributed. As regards the other difficulties, the old prismatic compass is their most satisfactory solution, except that it is more expensive, more liable to get out of order, and more accurate than the necessities of the case frequently require. A hunting case pocket compass with a bright reflecting inner surface of the cover was provided with a slot, one millimeter in width, reaching from the top to the north point of the compass dial. By holding this compass in the ordinary position for taking sight with the open cover at a distance of the diameter of the compass dial from the eye, it will be found that objects can be seen with sufficient distinctness to enable one to centre them easily, and at the same time the position of the needle can be read off by its reflection in the movable cover. This slot also takes the place of the gnomon in the ingenious compass devised by Major T. B. Brooks, some ten years ago, and like that compass may be used to determine the variation of the magnetic needle. In the absence of local attraction, the time of noon being known, the true north can be determined, and hence the magnetic declination of the place. Or the variation being known, the time of day can be determined by suitable marks on the periphery of the disc, or the variation being known, the needle can be used to discover the direction and amount of local magnetic attraction.

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Obituary Notice of Thomas S Kirkbride, M D. By John Curwen, M. D.

(Read before the American Philosophical Society, Jan 16, 1885.)

In the company of those who left England with William Penn to seek greater liberty of conscience and freedom of worship, was a family from the northern part of the county of Cumberland, who settled on a farm on the beautiful banks of the Delaware river, in Pennsylvania, a few miles above what afterwards became the capital of New Jersey. On this farm on July 31, 1809, was born Thomas Story Kirkbride, who inherited and cherished the religious faith and strong love of freedom which had led his ancestor to leave his native land and settle in what was then a wild and unexplored section of the country.

The early years of our friend was spent on this farm, and from the pleasant surroundings and beautiful scenery which met the eye was early derived that love of the beautiful in nature and fondness for laying out and adorning the grounds which formed so marked a trait in his character.

His academical education was received in the academy at Trenton, "which attained a high reputation under a succession of able masters," and was distinguished then and for years after for the excellent training given to its scholars.

He graduated from the medical department of the University of Pennsylvania in the Spring of 1832, and was very shortly afterwards appointed Resident Physician of the Asylum for the relief of those deprived of the use of their reason, at Frankford, remained there one year and was then elected Resident Physician of the Pennsylvania Hospital, where he remained two years, and had renewed opportunities of studying the subject of mental disorders in the department of that Hospital which, for eighty years, had been specially set apart for that class of disorders

After leaving the Hospital he opened an office in Arch street, below Fifth street, and with a strong predilection for surgery he had intended to

devote his attention to that branch. In October, 1840, he was elected by the Managers of the Pennsylvania Hospital to the office of Physician-in-Chief and Superintendent of the Department for the Insane, which had been in progress of construction for several years and was then ready for the reception of that class of patients

After examining the several institutions for the insane which had been constructed during the last few years previous to that date, he entered on the duties of the new position on the first day of January, 1841, and the first patient was received on January 9, 1841, and in a short time all the insane from the hospital in Pine street were transferred to the new Institution He gave himself, mind and heart, to the duties of his position, and his zeal and enthusiasm for the welfare of the insane never slackened so long as life endured.

Any one who will read the report of the first year of his administration will see clearly laid down the principles which guided and governed in all the years which followed, and enlarged experience, a more thorough knowledge and more ample means enabled him, with each succeeding year, to add to the resources of the Hospital and the more thorough treatment, medical, hygienic and moral, of those committed to its care. In the earlier years of the Institution great attention was given to laying out, adorning and the careful improvement of the grounds within the enclosure, embracing forty-one acres, so that ample walks for exercise, pleasant drives and cheerful views and surroundings, might direct from morbid fancies to more healthful ideas. The attention given to these matters was the relaxation from more exacting and imperative duties, and gave that degree of out-door exercise which one, in the delicate physical condition and feeble digestion which troubled him at that time, so much required, to give tone and vigor to his whole system.

In October, 1844, the Association of Medical Superintendents of American Institutions for the Insane held its first meeting in Philadelphia, and Dr Kirkbride was elected its first Secretary, and from that day to the close of his life, he always manifested the warmest interest in its welfare and progress, and took a very active part in all its proceedings, rarely being absent from a meeting.

The ablest deliverances of the Association on the construction and organization of Hospitals for the Insane and on kindred subjects were from his pen, and were so carefully and thoughtfully prepared that after the fullest discussion, by all the members, very little change was made in the phraseology and none in the sentiments or opinions advanced.

He was Secretary of the Association for seven years, Vice-President for seven years, and President for eight years.

His position at the head of the oldest Institution for the Insane in the country, and at the centre of medical education, naturally drew to him all those who were anxious to learn the latest and best plans and arrangements for the construction and arrangement of hospitals for the insane. He was constantly consulted in the arrangements of the State Lunatic

Asylum at Trenton, and to some extent in the plans of the State Lunatic Hospital at Harrisburg. These frequent consultations, joined with a natural fondness for architecture and building led him to prepare his book on the construction of hospitals for the insane, the first edition of which appeared in 1856, and the second and enlarged edition in 1880, having been arranged and prepared for the press during the convalescence from a severe illness which lasted many months and brought him very close to the borders of the unseen world.

In no work in the English language are the true principles of the construction, arrangement, and organization of hospitals for the insane more lucidly and more thoroughly set forth than in the last edition of that book, and were its precepts obeyed and its plans more closely followed, very few of those mistakes would be made in the arrangement of hospitals which give so much trouble and are so costly in their rearrangement.

He early entertained the idea of the separation of the sexes in buildings under the same general management, and this plan was more fully developed in the report for 1854. He labored with the greatest assiduity to collect by private subscription the money needed for the erection of such a building on the part of the property west of the hospital then in operation, and so faithfully did he give himself to this work and so zealously was he supported by the Managers of the Hospital that the greater part of the money was subscribed, and "the first stone of the new building was laid on July 7, 1856

"The formal laying of the corner-stone took place on the first of October, in the presence of a large number of ladies and gentlemen; on which occasion, addresses were made by Professor George B Wood, M D., Richard Vaux, Mayor of Philadelphia, Mordecai L Dawson, President of the Board of Managers, and Morton McMichael"

"The building was formally opened for the reception of patients on the twenty-seventh of October, 1859 The cost of the new Hospital with all its out-buildings, the wall surrounding its grounds, all its varied and expensive fixtures of every kind and the furniture in use, amounted to the sum of $355,907 57 This whole sum has been paid, or there are in hand abundant means for doing so, to be derived from unrealized subscriptions and from ground rents

"The fact that this whole work has been provided and paid for entirely from private subscriptions is worthy of remembrance in our local history."

When the Board of Trustees of the Pennsylvania State Lunatic Hospital at Harrisburg was appointed by Governor Wm F. Johnston, in 1851, Dr. Kirkbride was one of the Board, and continued in service until 1862. He took an active and energetic part in the organization of that Hospital, and his long experience and thorough knowledge gave him an influence with his colleagues which he exerted to place that institution in the best possible condition for the promotion of the welfare of its inmates, and no man ever had a more faithful and efficient friend and counsellor in all matters than the Superintendent of that Hospital during his connection

with it as Trustee Of his connection with the Pennsylvania Institution for the Blind for more than forty years, and the great interest manifested in the design and successful operation of that institution, and the great faithfulness displayed in the very constant attendance at all the meetings of the Managers, from few of which he was absent during the long period of his service, others can better speak who are intimately connected with it, but it may be permitted in this place to say from personal knowledge that, next to the Hospital of which he was Superintendent, no institution held a higher place in his regard and affection.

He received from Lafayette College the Degree of LL D in recognition of his eminent ability and the remarkable services rendered to suffering humanity.

While Dr. Kirkbride, by reason of his great ability and calm, deliberate judgment, was called to the discharge of such important trusts, that to which his life was really devoted and by which he will always be best known, was as Superintendent and Physician-in-Chief of the Pennsylvania Hospital for the Insane Assuming the administration of that trust with reluctance and hesitation of his own ability properly to discharge its duties in the spirit and in the manner in which he believed all such duties should be performed, he gave himself, mind and heart, to the work, in the spirit of his own oft-repeated maxim—what was his duty, was his pleasure

Association and friendship of the most intimate character, for almost forty years, and constant correspondence for more than thirty years, give to the writer an opportunity of an acquaintance with all his views on matters of common interest in the care of the insane, which enables him to speak in the most positive manner of what those views and opinions were. In every movement in medical societies, in the Legislature or in any other way which had a bearing on the care and treatment of the insane, Dr. Kirkbride, though not in all cases prominently before the public, was always consulted and his counsel and advice earnestly sought, and for thirty years, and these were years in which legislation was most active in that direction, no measure of any importance was enacted in the inception and progress of which he was not fully consulted in all the stages, and he never hesitated to use all his influence with those with whom it would be most effective, either in favor of any measure which might promote the welfare of, or against any which might be injurious to, that class in which he was so greatly interested. A proper estimate of his life-work can best be obtained by a careful consideration, in the briefest manner to render them clearly intelligible, of the various subjects which constantly and steadily claimed his thought and attention. No man ever gave more careful, assiduous, well directed and intelligent thought to all matters connected with the construction of hospitals for the insane, and the fact that the plan he elaborated, and which bears his name, has been incorporated in buildings from the St. Lawrence to the Gulf of Mexico, and from the Atlantic to the Rocky mountains, clearly proves its thorough adaptation

to the purpose It has been the fashion with some, who, with no practical experience, have pushed themselves forward in matters connected with building hospitals, to decry the plan as behind the age, but their plans have not yet been tried sufficiently long to prove their defects in all respects, and those defects will be found at the very points where they have departed from the well-considered details which he so carefully worked out.

"So different from ordinary buildings or other public structures are hospitals for the insane, that it is hardly possible for an architect, however skillful, or a board of commissioners, however intelligent and well-disposed, unaided, to furnish such an institution with all the conveniences and arrangements indispensable for the proper care and treatment of its patients. Nothing but a practical familiarity with what is required can do this. All recent experiments in planning hospitals without consulting experts, or asking their opinions before the adoption of the plan, as should be expected, have proved failures. No desire to make a beautiful and picturesque exterior, should ever be allowed to interfere with the internal arrangements, any more than the wish to have an elevated and commanding site should be permitted to compel the provision of costly roads, and the expense and annoyance of having everything, in all future time, carried to its great elevation. The interior should be first planned, and the exterior so managed as not to spoil it in any of its details.

"Although it is not desirable to have an elaborate and costly style of architecture, it is, nevertheless, really important that the building should be in good taste, and that it should impress favorably, not only the patients, but their friends and others who may visit it A hospital for the insane should always be of this character, it should have a cheerful and comfortable appearance, everything repulsive and prison-like should be carefully avoided, and even the means of effecting the proper degree of security should be masked, as far as possible, by arrangements of a pleasant and attractive description "

This is not the place, nor would time permit, to go into an elaborate description of the plan, but it may suffice to state that its main features consisted of a central building for all the administrative offices, with wings on each side, the first wing at right angles to the centre, and at the point of junction a space of ten feet left with windows from floor to ceiling to give ample light, the second wing parallel with the first, but thrown back so as to have windows from floor to ceiling at both ends of the hall, and the third wing still parallel to the second, and the windows of a similar character at both ends of the hall. From this fact of the wings running parallel with each other, it has been called also the linear plan The halls of the wings are twelve feet wide, and the ceilings of each story twelve feet high; rooms on both sides of the hall, and in the centre of the hall large bay windows to give light, and afford a pleasant sitting-room for the inmates, in addition to the large parlor; every ward to have in it all those conveniences which may be requisite to promote the comfort and well-

being of those for whose use the hospital is constructed. The whole establishment to be so arranged as to be under one roof and in every part to be as light, bright and cheerful as it is possible to have it, and with the object of promoting the comfort and convenience of all, with the least expenditure of time and labor.

Any one wishing to be thoroughly conversant with all the details of construction of hospitals for the insane, should read attentively this work on the construction and organization of hospitals for the insane. The work will be found most admirable for the clearness of all its statements on the different points, most thorough in its elaboration of details, and bearing in every line the impress of a clear head, sound judgment and most intimate acquaintance with everything which can have a bearing on the promotion of the restoration, comfort and welfare of the insane, directed and guided by that earnest conscientiousness which was such a prominent trait in his character.

In forming an opinion on any subject he was never hasty, but submitted all to the careful scrutiny of a sound judgment, which led him to examine with a full knowledge of all the facts bearing on the point which could be obtained. A warm, generous heart, keenly alive to all the finer impulses of humanity, led him so to direct all his thoughts and actions that self had no prominence, but the good of others and the advancement of their happiness was the great aim and object of all his efforts. The more intimately his opinions, on every subject to which his thoughts were directed are known, the more thorough will be the conviction of each mind, that every faculty of his mind and every impulse of his heart urged him onward in the path of entire devotion to the welfare and happiness of all he could reach.

No uncertain sound attended his utterances on all matters pertaining to the welfare, care and treatment of the insane, and the mild and pleasant manner in which his opinions were expressed served to carry conviction to many minds which would have resisted a more dogmatic expression, and added force was given by the evident sincerity and devotion to truth and duty which dictated them. No more positive indication of the confidence reposed in his judgment, and the earnestness and sincerity with which he urged his views, can be looked for, than in the collection of the large amount for the erection of the Department for Males of the Pennsylvania Hospital for the Insane, by far the larger portion of that amount having been obtained by his personal efforts in direct application to individuals, and any one who will examine that long list will see the uncommon tact and energy displayed by him in his appeals to all classes and conditions of men.

On all matters pertaining to the welfare of the insane his opinions were clear and decided, and formed with a care, discretion and deliberation which those would do well to imitate who so freely criticise and often so summarily reject them. To some of those opinions on matters which have been so much discussed in late years, attention must be given in order to

obtain a clear idea of the work which he performed, and the clear head and generous heart which directed that work

The employment of mechanical restraint has in late years received more than usual attention in the reaction from its excessive use in England many years since, and on a subject of such practical importance in the treatment of the insane, it is only just to quote the opinions of one who had the most ample means of testing it, and who, while believing in its use in certain specified cases, rarely, to use the words of Dr. J C. Bucknill, of England, carried his theory into practice His uniform testimony, derived from careful observation and experience, for he had seen its modified use while resident physician of the Friends' Asylum and of the Pennsylvania Hospital in Pine street, and holding that opinion, not because he had formed it, and was reluctant to change it, but simply because he believed that the best interests of a certain class of insane, and that a very limited number required it for their benefit, was, in the language of a resolution of the Association of Medical Superintendents of American Institutions for the Insane, adopted in October, 1844· "That the attempt to abandon entirely the use of all means of personal restraint, is not sanctioned by the true interests of the insane." That resolution was drawn by men, who carefully considered the words they used before committing them to paper.

Dr. Kirkbride discussed the subject in his reports, from the year 1841 down to 1877, in which latter year he used the following language as a full summary of his views : "It is an error leading to wrong popular impressions, to speak of any hospital for the insane as being conducted without restraint. There is no such thing, and cannot be Where an individual is placed under the control of another, even where the control is of the gentlest kind, it can hardly be said he is without restraint. What is meant is, not that a hospital is without restraint, but is without mechanical means of restraint, and these can be omitted anywhere on provision of the proper substitutes. Mechanical restraint is rarely necessary, and only in a few, simple forms, but when it is required, it is a question to be left for the decision of whoever directs the treatment of the patients No one recognizes more thoroughly than is done here, the impropriety of subjecting the insane to unnecessary restrictions, and that the precise extent to which freedom of action may be carried can only be discovered by careful observation and the study of the peculiarities of every individual patient The only persons who can properly decide just how far restrictions shall be carried, and freedom be granted in an institution, are its medical officers, who, having all the responsibility for the results, if at all qualified for their positions, may safely be entrusted with the power to decide all such questions, which should really be regarded as a part of the treatment of the patients."

In the matter of occupation, employment and amusement of the inmates of a hospital, Dr Kirkbride always held advanced opinions, which the great majority of men have not yet attained to. He held, and held justly,

as every reflecting man must admit, that some means of diverting the mind from morbid ideas to more healthy thoughts, was as important as medicine to a disordered bodily system, and that the two must be carefully adjusted to the condition of the individual at the time. He was never satisfied with what he had done, but was always reaching out for something newer and better in addition to those already in use. This idea runs through all his reports, like a golden thread, to brighten and strengthen them. In reference to occupation, a wise caution is given, which should be carefully pondered, if they could do such a thing, by those whose ill-digested opinions indicate a much greater amount of zeal than knowledge.

"Moderate, wisely regulated labor is really serviceable to many of the insane, but hard work, so carried on as to be profitable to any institution, is very rarely of benefit to the patients, while often it is injurious to an unsuspected extent, to a class whom the excitement of disease stimulates to extraordinary exertion Besides these, there are others, who uncomplainingly labor at the tasks assigned them, only because they are urged to do so, when their natural instincts would lead them to enjoy the rest, for which they have a persistent craving, and which comes from an actual want of strength dependent on the existenee of disease. It is never to be forgotten by those having charge of the insane, that much as the malady differs in form and degree, all of these cases are as truly the subjects of a serious disorder in a delicate organ as are those who have any other sickness, in which the sufferers may be so much better able to describe their true condition, and to secure proper attention to their wishes In providing day occupation for the insane, much of it must be very different from the hard work from which alone any material profit can be anticipated. For much the larger portion of the patients, walking or riding through the grounds, or in their vicinity, with all the attractions that can be connected with them, will be much more valuable as remedies and nearly as profitable pecuniarily, as labor usually is. Every one of the many forms of diversion that should always be liberally provided, and all the games, out doors and in-doors, especially those that give active exercise in the open air, have a positive value, and really contribute more or less to the great objects for which these hospitals are established. The labor problem in regard to the insane is probably best settled by the conclusion, that it is hardly possible to exaggerate the importance of occupation of some kind for every class, but also, that harm, quite as easily as good, may follow employment, in unwise forms, and that a practical knowledge of the whole subject in regard to kind, amount, and the physical and mental conditions of those on whom its effects are tried, is indispensable to secure the best results from its use

"The necessity for entertaining and amusing the patients of a hospital for the insane, and giving them suitable varieties of occupation—no matter what is the character of the institution—is now generally conceded For the day-time reasonably good arrangements are commonly made for effecting these objects, but there is a long period in the evening—often amount-

ing to several hours—when out-door pursuits are suspended, and when, without carefully systematized arrangements, the patients go through a dreary period of monotonous and unprofitable existence, for which there is really no necessity If it is desirable to correct this state of things for one evening of the week, it is equally so for every other. It is no more difficult to make these evening entertainments a daily provision, allowing nothing to interfere with their regular performance, than it is to provide for the numberless other needs that come up at stated intervals in the daily routine of hospital life. In making out the estimate for the provision or support of any of these (State or municipal) institutions, a liberal allowance should always be made for suitable rooms for these purposes, for books and papers, for inexpensive pictures for the walls, for daily occupations and for evening amusements in all their variety; and most assuredly no part of the expenditures—although this may do its work ever so quietly—will more certainly contribute to the happiness and improved condition of the patients, or tend more to elevate the character of the institution, giving abundant returns for all the money thus appropriated. These are a part of the varied means which are sure to aid in the restoration of those who are curable, in securing the comfort and happiness of those who are not likely to be restored to health, and the quiet and good order of the household"

To trace out and understand the wonderful influence which he had over his patients, and how he induced them to adopt most readily the plans which he believed would surely advance their restoration and add to their comfort, can best be done by considering his wondrous patience, and his devotion to everything which had a bearing on their welfare, and the sincerity which they felt sure directed every thought and movement. His thoughtful nature was always looking forward to what could be made most steadily and certainly available for their pleasure and for the promotion of their mental and physical health Until the erection of the Department for Males, he made it a rule to see all the patients under his charge in the morning, and if anything prevented that visit, he was sure to take an opportunity in the course of the after part of the day, to attend to what he considered a most imperative duty. That visit was not a mere perfunctory duty, but he always took occasion to inquire, particularly, into the wants and feelings of the individual, hear all that he had to say, give advice, soothe, cheer, or so impress the person with his interest in him, and his earnest desire to benefit him, that he felt in every way, for the time, relieved, and looked longingly for the return of the same kindly attention. His manner, his address, his patient listening to all complaints and grievances, the gentle tone of his voice and the sympathy which manifested itself in every tone and action, had a wonderful effect on those who were depressed and greatly cast down, as well as on those of an opposite character.

He was a most earnest advocate of every medical, hygienic and moral means, which could be made available for the restoration and comfort of

those placed under his charge, and he sought to impress, not only all these views, but all his interest in his patients, on those who had more immediate direction. The rules, which he prepared for the conduct and guidance of those entrusted with the immediate care of the patients, show how zealously he sought to impress his own principles and practice on all who came within the reach of his influence, but the example of his daily conduct impressed the lesson more deeply than any written code could have done. No one could fail to feel the influence of that genial, gentle nature, constantly before him, and not be impressed with its great worth, and the effect it must necessarily have on all who could be reached by it. When the physical frame could no longer bear the strain put upon it by the constant visits to the wards, in all their detail, the interest was still extended to all, but more directly expended on those whose restoration could be most certainly effected by it.

Of a naturally quick and impulsive temper, that was so effectually under control that none would have suspected its existence, unless some wrong or injury were done to the insane, and then the rebuke came, sharp and decisive; not in an angry tone, but as the result of that indignation which such a sensitive spirit would naturally feel, on witnessing, or becoming acquainted with any violation of the better instincts of true manhood.

Like all genuinely conscientious natures, he was very sensitive, and seeking with unaffected honesty and truthfulness to do all in his power for the relief of suffering humanity, he was naturally, perhaps unduly, sensitive to the attacks made by many, whose philanthropic zeal was often assumed to make an impression, in their own favor, on their fellow-men. Certain it is, that he was very much harassed by the malicious attacks of designing persons, whose utter lack of true benevolence led them to say and do things, totally at variance with truth and justice. When in feeble health, and endeavoring to do all in his power for the benefit of his fellow-men, he was assailed with very unjust statements, made by those whose misguided zeal led them to the utterance of strictures on his character and professional standing, which their high religious profession should have made them blush to make public, without a more thorough investigation of the true facts. In the minds of those who knew him best, the impression is very deep that those strictures had very much to do in bringing on the condition which ultimately resulted in his death.

Deeply imbued with the religious principles of the Society of Friends, in which he had been educated, while placing little value on various externals of the Society, he endeavored, consistently, to carry out the principles laid down by them, in all his intercourse with his fellow-men. To a disposition, genial, gentle and kind-hearted, he united great decision and determination of character, and, convinced after careful examination that he was right, he kept steadily on in the course he believed to be correct, not deviating in the least from what he believed to be the true line of duty. Generous and liberal-minded, strong in his attachments and friendships, he cherished no feelings of enmity against any, but strove to live in peace

and harmony with all, and, when others refused to act harmoniously, quietly going on in the line of duty, avoiding contention while adhering strictly to what he believed to be truth and justice. His generous mind revolted at all pretences and attempts to make the worse appear the better reason, and he scorned all deception

He possessed a wonderful tact in his intercourse with the insane, which, combined with unfailing good nature, and honesty of purpose, gave him great power, which he always used to advance their interests in the fullest manner. Calm and self-possessed in scenes where others were agitated and alarmed, he exercised the happy faculty thus enjoyed, with great judgment and discretion, thus evincing in the clearest manner his power to direct and control. No trait of his character was more prominent than his single-hearted devotion to every good word and work, and in this, and in the earnestness and conscientiousness with which his work was performed, he strove to follow the example of Him, who always went about doing good.

Biographical Sketch of the Rev. Elias R. Beadle, D.D., LL D.
By D Hayes Agnew, M D.

(Read before the American Philosophical Society, February 6, 1885.)

To preserve in some tangible or permanent form a record of the life-work of those, who, after having achieved distinction in some one or more of the various spheres of human pursuits, have gone to swell the ranks of the great silent majority, is a custom no less commendable than beautiful. In accordance with this time-honored usage, the duty has been imposed upon me, of preparing a memoir of Elias R. Beadle, late a member of the American Philosophical Society. The delegated task is one sweetened by the recollections of a close companionship which existed between the writer and the deceased during all those years in which he wrought in this goodly city. Elias R. Beadle was born at Cooperstown, Otsego county, in the State of New York, on the 13th of October, 1812 He was the son of Henry and Susan Squires Beadle. There were only two children of these parents, the subject of the present sketch, and Doctor Tracy Beadle, late of Elmira, New York.

Young Beadle was early designed for a mercantile life, and, with this object in view, was placed in a store, in the town in which he was born, at the tender age of thirteen. History furnishes many examples of misunderstood genius; of fruitless attempts to turn the drift of a boy's life into unnatural and uncongenial channels.

And so with young Beadle, possessing rare powers of head and heart, with an insatiate thirst for the acquisition of knowledge, it was impossible that a mercantile pursuit, the duties of which were so routine and mechanical, should prove other than repungnant. Accordingly, in a short

time we find him acting as assistant to his uncle, Judge Foote, in the office of Surrogate It was no doubt while discharging the duties of this position that Dr Beadle acquired his characteristic, clear, bold, running style of penmanship. In the position of the letters one might readily divine the character of the man, each one inclining strongly forwards in close pursuit of its predecessor, and all pressing onwards like a racer in the home-stretch towards the desired goal It was while engaged with his uncle, and at the early age of seventeen, that conviction of duty led him to make a public profession of religion The manly decision of the son, decided a similar course on the part of the mother whom he tenderly cherished, and both, at the same time, connected themselves with the Presbyterian Church of their native town

How often do we attribute to chance or accident what is really the orderly prearranged plan of a divine force. Here is a young man, richly endowed by God with all the natural gifts of a great preacher, but he is poor, and without the influence of powerful friends, through whose assistance the cultivation and training of these native capacities might be rendered possible But mark! how human extremity is linked with divine opportunity. A stranger, while attending Court at Cooperstown, leaves his lodgings on a pleasant evening for an aimless stroll He passes the lecture-room of a church in which a prayer meeting is being held He is induced to enter A youth of seventeen is praying. Earnest, tender, importunate, he is pressing his suit with a grace of diction, and an affluence of Scripture thought far beyond his years The surprise and interest of the stranger increase; he remains until the meeting is dismissed, and then seeks an introduction to the youthful speaker. That youth was Beadle, and the stranger, Judge Allan Stewart, who, fascinated by the extraordinary gifts of the young man, at once tenders the means for a theological education. Scarcely had the student entered upon his labors, when he was overtaken by a sudden and dangerous illness, and from which he only recovered after a tedious and prolonged convalescence. After regaining his health, young Beadle removed to Albany in order to continue his theological studies under the instruction of the Rev. E W. Kirk, who, at that time, was pastor of the South Presbyterian Church, and a man of considerable distinction, both as a scholar and as a preacher. During the two years in which he remained in Albany, Mr Beadle was obliged to contend with the discouragements of feeble health, the confinement from close application to study telling severely on a constitution naturally delicate At twenty years of age he removed to Utica, New York, and believing that an active outdoor life would conduce to the improvement of his general health, he accepted an agency in the interest of the American Sunday School Union, the territory of the itinerancy extending over seventeen counties of Central New York Brought from the nature of this work into contact with the multiform sides of human character, it was doubtless now that Dr. Beadle acquired, in some measure at least, that marvelous adaptability to place and circumstance, and that deep insight

into human character, which constituted one of the foremost characteristics of the man It is impossible to overestimate the value of such an experience to either the professional or the business man ; it is often the potent personal equation which imparts point and practical power to culture and learning.

In 1835 Mr Beadle was licensed to preach, and from this date commenced his career as a minister of the Gospel

During his sojourn at Utica, he formed the acquaintance of the Rev. Asa T. Hopkins Their friendship ripened into a strong attachment, so real and sincere, that when the latter was called to the First Church at Buffalo, Mr. Beadle, on the earnest solicitation of his friend, was induced to take up his residence in the same city, where he discharged the duties of City Missionary during the week, at the same time becoming, practically, co-pastor with Dr Hopkins, whose pulpit he occupied during a portion of each Sabbath It was here that the power of Dr Beadle as a preacher began to attract public attention Crowds flocked to hear him, and it was at one of these morning services, when with eloquent speech the young preacher had unfolded the treasures of his text, that the applications of its lessons were made with a pungency and power so startling, as not only to electrify the spell-bound audience, but to bring the old pastor in the pulpit to his feet, who, grasping the hands of the speaker in his own, and with tears streaming down his cheeks, exclaimed with deep emotion, "Young man, you have gifts which will yet make you one of the foremost preachers in America." On another occasion, while addressing a vast audience composed of young men, from the text of the prodigal son, and while delineating in vivid colors the spiritual poverty of the sinner, of which the prodigal was a type, and when a felt silence pervaded the whole assembly, a young man, who saw in the dreadful picture a portraiture of his own condition, under irrepressible feelings of conviction, rushed into the aisle, and moving down towards the speaker, cried out in tones of the deepest distress, "I am that man, I am that man."

No fact in history is more true than that early studies or occupations give a coloring and a drift to the whole future work of a man's life Gray's poetic career was inspired by reading Virgil It is said that the peculiarity of shadow which belongs to the pictures of Rembrandt, was due to the direction of the light under which he wrought in the composition and execution of the first productions of his brush.

And so with the subject of our sketch, his early itinerancy in the service of the Sunday School Union, and his labors in the city of Buffalo, had naturally attracted his thoughts towards the missionary field.

This bias was no doubt strengthened by the additional circumstance of having assisted in the preparation of Dr Asahel Grant for labor among the Nestorians, and probably what was equally influential, the close correspondence which had been kept up between himself and Mr. Alfred North, then engaged in missionary work at Singapore, India. The motives which carried the thoughts of Mr Beadle to distant lands, were not that he might

consummate some cherished theory in sociology, or to enlarge the sources of knowledge by travel. He was no enthusiast, like Fenelon, contemplating the impossible project of reconciling Grecian culture and philosophy with Apostolic truth, nor was he led by curiosity, longing to linger over the historic sights of ruined porticos or academic groves, where, surrounded by admiring followers, philosophers like Socrates or Plato once taught Rather would he have sought the market places, where the great Apostle of the Gentiles announced a philosophy which could boast a divine origin, and which was destined to conquer the world by a weapon unknown to the heroes of Marathon, that weapon the sword of the Spirit. There are thousands who linger about the shores of Galilee, wander over the hills of Judea, or gaze with curious eyes on the great foundation stones of the Temple at Jerusalem, animated only by archælogical taste, or by a historical association. True, these motives are not blameworthy. Methinks that if I could stand, beyond all peradventure, on the identical spot pressed by the feet of the Nazarene, when He looked down upon the doomed city, and saw with prophetic vision her coming calamities, or if I could sit down on the very brink of that well, under a Syrian sun, where the tired Jesus sat, that I could realize a more vivid sense of God with man, than where faith alone must fill the void of sight and touch It was not, however, simply to tread the land of sacred story or to feast the eye on the scenes of events which had been foretold by inspired seers that Dr Beadle longed for the foreign field, but it was in the Spirit of His Master, to carry a gospel which was capable of regenerating lost men The time, however, was not ripe for the consummation of this cherished object, which lay nearest to his heart Through the combined influence of untiring labors, and the inhospitable climate of Buffalo, he was again brought to a sick bed by an attack of pneumonia, which proved to be of so severe a type that for a long time his life was in great jeopardy. After having sufficiently recovered his health, and in order to seek a more congenial climate, Mr. Beadle removed to Albion, New York, and during his stay, which was about two years, discharged the duties of pastor to one of the churches of that place. With returning health and strength, the old passion resumed its sway, and, in 1828, he formally offered himself to the American Board of Commissioners for Foreign Missions, willing to go to the Indians, west of the Rocky mountains, to the Sandwich Islanders, to Syria, or wherever the Board saw proper to send him. The offer was immediately accepted, and an order issued for his departure to the Mediterranean, the objective field of labor being among the Druzes of Mount Lebanon, and to which he sailed, accompanied by his wife, in June, 1839. On their arrival at Beirut, war had broken out among the natives along the slopes of Lebanon, which effectually closed the door against all mission operations among this people. For three years, in expectation of being able to occupy the field of original destination, Mr. Beadle was changed from place to place, and among others to Constantinople, but the climate of this splendid city of the Golden Horn proved inimical to his sensitive

lungs, and as the condition of the country continued to be turbulent and unsettled, he returned to the United States, after an absence of three years. During the year 1843, he remained in New Haven, devoting the entire time to rest and study.

In 1844, on the invitation of the Rev W. A. Scott, he repaired to New Orleans in order to deliver a course of lectures on Syria A year later Dr. Beadle returned to the same city, which for six years he made the theatre of a most remarkable ministerial work. In this period he organized three Presbyterian churches, all of which remain as permanent and influential organizations. It was while a resident of New Orleans, in 1847, that a fearful visitation of yellow fever occurred in the city. Eight members of his family, including servants, were attacked by the disease, five being down at one time, but notwithstanding the great mortality of the epidemic, all recovered I remember on one occasion, when relating some of the scenes witnessed during the prevalence of the disease, and when the whole community seemed to be in a state of panic and fear, Dr. Beadle spoke of the singular moral effect of a single unterrified individual in inspiring courage and hope With the dawn of the morning, and again with the setting sun, an old negro going to and returning from his daily toil, sang at the top of a clear musical voice, "Way down on Suwanee river." Whether the song was inspired in order to keep up the courage of the singer, or, like the warble of a bird, was the simple outcome of a heart free from fear or care, he was unable to say, but the moral effect on the spirits of himself and others was perfectly magical.

While in New Orleans, Dr Beadle, in addition to his ministerial labors as the regular pastor of the Prytania Street Church, one of the three which he organized in that city, was the associate of the Rev. Dr. Scott in establishing and conducting a religious publication, the *New Orleans Presbyterian*, a paper distinguished alike for its able advocacy of the distinctive doctrines of Presbyterianism, and its high literary merit.

In 1852 Dr. Beadle was called to Hartford, Connecticut, to the Pearl Street Church This was a new organization, and in many respects a difficult field to fill, inasmuch as the incumbent would be measured alongside of a number of the ablest preachers and scholars in New England Beadle at this time was in the very prime of his power, and at once assumed a commanding position among his ministerial brethren In a short time the new church was crowded to its full capacity with young men, and during the ten years in which he lived and wrought in Hartford, no man ever was more deeply entrenched in the affection of a people than was Dr. Beadle. Until the time of his demise, he was to them the son of consolation, responding to their often repeated calls by his personal ministrations in times of sickness or sorrow and of death.

In the winter of 1859 he had a return of his pulmonary malady, and was compelled to take refuge in Santa Cruz Few who saw the wasted man depart entertained any hope of ever seeing him return alive. Yet, after a sojourn of eight months, the abscess in the lung closed, and in 1860, one

year from the time of his departure, he had again resumed his pulpit and pastoral labors In 1863 his pastoral connection with the Pearl Street Church was dissolved. Dr. Beadle, though eminently a man of peace, and in disposition gentle as a woman, had nevertheless an imperial will, which made him ever loyal to convictions of duty. To these he was true as steel. All know that the fiery feelings engendered by the breaking out of the war between the two great sections of the country often carried men away from the stable moorings of reason, and provoked words and acts, which, in cooler moments of reflection, were deeply regretted. Some Christian people believed that the pulpit was the proper place to discuss the vexed questions involved in this fratricidal strife. Dr. Beadle, and there was none more loyal, regarded the introduction of these themes in such a place as a prostitution of the sacred office, and rather than surrender to the fanaticism of the hour, asked in the interest of peace, that the relations between himself and the people of the Pearl Street Church be dissolved, and in accordance with this wish, the ties which had for so many years bound pastor and people together in the bonds of Christian fellowship were sundered.

In 1863 he again sailed for the East, and in company with Dr William M. Thompson, the well-known author of the "Land and the Book," he visited Egypt and Mount Sinai, the object of the visit being to identify the path of the children of Israel in their exodus to the promised land.

It was after his return from Egypt that my personal acquaintance with Dr. Beadle commenced It was in the Tenth Presbyterian Church of this city where I first had the pleasure of hearing him preach. I remember well he entered the church and took the back seat on the side aisle, and when the hour for service arrived, he arose, walked with a rapid, nervous step down the same aisle, and ascended to the pulpit. The members of the Second Church will remember that he rarely passed down the central aisle. There was something about the man which immediately awakened my interest. The sharply cut features, the deep lines which furrowed a thoughtful face, and the quick, nervous movements all revealed the fire which flamed beneath the surface. Nor was this interest at all lessened after the speaker rose to proceed with the services of the day. The voice and manner, the form and force of expression, the elegance of diction, all conspired to make one magnificent harmony, and you could not fail to feel that in the delicate wiry body of the speaker, God had enshrined a soul full of all manner of beatitudes.

During the temporary absence of Dr. Boardman and of Dr Crowl, the congregation of these pastors worshiped together, and Dr Beadle supplied their pulpits Notwithstanding the heat of midsummer, and consequently the depopulated state of the city, he soon attracted large congregations composed of highly educated and appreciative hearers.

The following year, 1864, Dr Beadle spent in Rochester, supplying for a time a vacant pulpit in that city, but the rigor of the climate in that part of the State of New York, soon compelled him to seek a more congenial spot,

and in 1865 he was called to the Second Presbyterian Church of Philadelphia, then situated on Seventh street, between Market and Arch In consequence of the drift of population westward, and the encroachment of trade, a process of disintegration had been going on for years in this old historic church, which rendered a change imperative, and when the few remaining worshipers turned their backs on the spot hallowed by so many tender and sacred memories, it was with feelings somewhat akin to those experienced by the sons of the captivity, when required to sing a song of Zion by the willows of Babel. After leading a kind of nomadic life for some time, this body at length selected the site at Twenty-first and Walnut street, and there erected the present imposing edifice, where the last and not the least prosperous years of Dr. Beadle's singularly successful ministry were spent, and where, like a heroic soldier he held aloft the Gospel banner, until the victory was won.

On Sabbath morning, the 5th of January, 1879, Dr. Beadle preached with his usual earnestness and power, and at the close of the service, touchingly announced the consummation of a long cherished hope, namely, that he might live to see canceled the onerous debt which had hung like a pall over the beautiful temple in which he and his people had worshiped, at the same time saying, "that his work was now done." Whether any projected shadow had announced the coming event, I know not, but the words were prophetic, it was his last Gospel message, his work was done One hour later I was hastily summoned to his aid. On his way to the residence of his brother-in-law, Mr Horace Pitkin, the day being cold and windy, he had been seized with the agony of cardiac angina, requiring to be assisted into the house. On entering the room I found the poor sufferer seated on a sofa; but alas! how changed The face an hour before beaming with exultant joy was now shrunken, pinched, pallid and cadaveric; the wrist pulseless, and with a desperate clutching of the fingers there was heard a low plaintive half-suppressed moan, like one in hopeless trouble. I felt how vain was the help of man. A few hours later, or shortly after midnight, the gentle spirit of Beadle was released from its mortal environment, and passed from the Church Militant to the Church Triumphant

But this sketch would be far from being complete if we failed to study, from a much nearer point of view, those qualities which constituted the individuality of this remarkable man, and which revealed the secret of his successful and distinguished career My intimacy with Dr Beadle commenced immediately after his removal to Philadelphia, and for years, unless interrupted by absence from the city, our companionship was almost daily, consequently I came to know the man through and through.

Beadle was a many-sided man Like a precious brilliant, every facet showed with soft and luminous rays. His temperament was what a medical man would designate as nervo-sanguine. Though patient, prudent and self-controlled, he possessed, nevertheless, an immense momentum or active force of brain and heart, which kept him ever in motion, and in-

spired the ardent, earnest and untiring enthusiasm with which he worked, whether the objects of pursuit were small or great There was withal a singular thoroughness in all that he did, a determination to get at the core, or as John Brown would say, the lion marrow of things. One of the most formidable disabilities with which Dr. Beadle had to contend was feeble health He began life with a great soul in a delicate body, and on several occasions was compelled to call a halt in order that the exhausted energy of the overworked machine might be regained. Thrice was he so near death that little hope was entertained of his recovery, much less of being able to take up the toil of beloved work.

A warm personal friend and admirer of Dr Beadle, Prof Benjamin Silliman, the Elder, once said, "O Beadle! if that soul of yours could be shot into a robust body, what a power you would be in the world" None but those who were very close to Dr. Beadle have any conception of the fierce struggle maintained by this noble man against physical infirmities. It was the frequent reopening of an old abscess cavity of the lung, which occasioned the violent paroxysms of cough and profuse expectoration which so often interrupted his speaking in the pulpit I may also mention a fact which was doubtless little suspected by his friends, and which served to further complicate this constitutional weakness He was the subject of chronic Bright's disease, and that for thirteen years, or up to the time of his death, the progress of this grave affection required to be kept in abeyance by periodical treatment, nothing indeed, but an imperial dauntless will, and a perennial spring of vitality, which animated the tough fibre of his slight frame, could ever have enabled this man to weather the cross-currents and storms of so checkered a life, and to anchor in a haven of sixty-seven.

An inborn, insatiate thirst for the acquisition of knowledge, associated with a remarkable versatility of tastes and capacities, led Dr. Beadle to cultivate various departments of natural science. It was, however, more particularly in the realms of conchology and mineralogy that he was most deeply interested His collections of shells and minerals formed one of the most extensive and valuable private possessions of the kind in this country, and scarcely was a vacation passed without the same being enriched with numerous spoils from the mountain, and from the sea Several educational institutions of the county are indebted to his generosity for large and valuable additions to their cabinets. Any one who may have visited his rooms on Eighth street, will scarcely fail to remember, among other rare specimens which lay on his table, a magnificent section of a petrified palm tree, with its concentrically arranged laminæ of variegated silex answering to the original layers of ligneous matter. The circumstances under which Dr. Beadle came into possession of this valuable piece are quite characteristic of the man. Dr. George M. Graves, in a letter to the Rev Heber H. Beadle, writes that in 1864 he spent a month in company with Dr. Beadle, and Dr. Thompson traveling from Cairo to Egypt, over the French canal and through the desert to Mt. Sinai. At

the petrified forest near to Cairo, the writer had found a large stony fragment of one of the trees which originally formed a part of the grove. Placing the piece before him on the neck of his donkey, he determined to bring it with him to America After wrestling for some time with the unwieldly mass; he became disgusted, and cast it down upon the sand The temptation to recover the valuable specimen was too great to be resisted by Dr. Beadle, who, after a few moments' reflection, dismounted, and placing the precious stone before him, on the withers of his beast, at length, after allowing it a number of times to roll over the head of the stumbling donkey, succeeded in bringing it into camp, from which it was shipped home, and, after being polished by the wheel of the lapidary, it was allowed to grace the cabinet of its owner, "a thing of beauty and joy forever."

It was during this excursion that another little incident occurred, which revealed the happy vein of subdued humor which lay just beneath the surface of our naturalist's character A fatiguing day's march over the burning sands, had brought the little company, suffering from the combined effects of thirst and exhaustion, to an oasis in the desert, where with joy they had hoped to cool their parched mouths with the limpid water which lay under the shadow of a few palm trees. Before, however, they were able to dip their vessels, the camels, attracted by the scent of water, rushed impetuously into the pool and befouled it with mud While the thirsty travelers stood dazed with surprise and disappointment, Dr Beadle, as if enjoying the dilemma, and with a half mischievous smile on his face, though suffering equally with his companions, began to expatiate on the delicious qualities of Philadelphia ice cream

Notwithstanding his great fondness for the natural sciences, Dr. Beadle did not allow subjects belonging to this realm to charm him away from other studies. Traveling and living as he had been for several years among peoples of diverse speech, it was natural that he should seek to obtain a knowledge of different languages With the same facility with which other subjects were mastered, he acquired an excellent understanding of both ancient and modern tongues, some of these he spoke with a fluency little inferior to that of his mother speech.

His desire to accumulate new stores of knowledge increased with age, and seemed to be unappeasable. Though reading in all directions, this was nevertheless conducted methodically His habit was to keep five irons in the fire at the same time. These were theology, science, biography, history and travels Like Baron Larrey, the great surgeon who followed for many years the fortunes of Napoleon Bonaparte, when contemplating a visit to some new country or district, he would gather from all acceptable sources whatever could be learned of the region or its inhabitants, so Dr. Beadle prepared for all his excursions, scientific or otherwise, by preliminary study.

His industry was remarkable and always regulated by system and dis-

patch. No man more than he realized the truth of Bonar's expressive lines:

> Our age is but the falling of a leaf,
> A dropping tear,
> We have not time to sport away the hours,
> All must be earnest in a world like ours

Rising early in the morning he breakfasted, in summer, at six, and in winter, at seven o'clock. Half an hour later he was in his study, and as Hayden, when composing his "Creation," always addressed the Creator before touching the cords of his instrument, so Dr Beadle before beginning the work of the day, reverently sought the aid and guidance of Him, who is the source of all knowledge and wisdom He never wrote after mid-day, but held himself, after that time, ready for any interruption, professional or otherwise He wrote with amazing rapidity, and always with the old historic quill. No pauses were made in search of fitting words or for the rearrangement of sentences Unlike the sculptor, who, with ponderous strokes first fashions from the shapeless mass of marble a rude outline of the figure in contemplation, reserving for the finer lines of force and expression a thousand repeated delicate touches of his chisel, Beadle never stopped to redress or reconstruct. Whatever the subject, it had been thought out and arranged, mentally, while on the wing here and there, and when he came to the work of the study, the mental picture required for its visibility only the mechanical movements of the hand. There is among his many letters, written to me at various times, and from different places, scarcely a single one in which either an erasure, or an interlinear word can be found His style was vigorous, compact, incisive, and remarkble for perspicuity. Every thought was expressed in fitting language, and with a purity and elegance peculiarly his own

On the platform he was inimitable. It mattered not in what order he was placed among speakers, first or last, he knew just how to gather up and condense with marvelous tact the salient points of the occasion, and without noisy declamation or a single unnecessary word, in a few polished, fiery, and logically connected sentences, to strike the nail exactly on the head.

It is not common to find order associated with great energy and dispatch, yet this was notably the case in the character of Dr. Beadle. While moving like a comet, there was nothing like hurry in his work.

A facility for mere details tends greatly to contract or dwarf mental power, but when joined with an executive push, the union cannot fail to prove a potent force in the battle of life. At no time did this twin force exhibit itself to greater advantage than when an invoice of minerals or shells had been received, and when the contents of the boxes were spread over the floor of his study in chaotic confusion It was almost phenomenal to find that in a few hours the hand of a master had, with magical celerity, classified and relegated each specimen to its proper place, and that even the dust had been cleared away with scrupulous care His rooms were always

models of order and neatness. There was not a nail or a chair, a hammer or a piece of twine which had not its specifically assigned place. I was not one of those who first entered Dr. Beadle's study after his death, but I would venture to say, that I could locate the exact position occupied by each piece of furniture in that room, even to the inkstand, letter weight, blotter and other articles of his table.

Not only was he methodical in the arrangement of working material, and in the disposition of his time, but he was also scrupulously exact in the disbursement of income He was old-fashioned enough to believe that there were some things belonging to the Mosaic economy which might be advantageously introduced into the ethics of modern life. He held to the doctrine of stewardship, that God, as well as Cæsar, had claims on every man's property, and, accordingly, he faithfully tithed, not mint and cummin, but his income, presents as well. He did not invest his money, and then tithe the income, he was too conscientious to do that, as investments often take wings and fly away, but whenever salary or other moneys were received, one-tenth was immediately withdrawn, and the amount placed to the Lord's credit, and, not unfrequently before the day was gone, the entire sum was distributed in those directions, where, in the judgment of the donor, it was calculated to effect the most good

Men of method, of exactness in details and economizers of time, are also punctual men, and this was eminently true of Dr. Beadle. Of the many appointments we made together, extending over a period of several years, I cannot recall a single instance in which one was forgotten; before the last minute of the designated time expired he would appear. "Name the time when you will meet me at a particular place in London," said a friend to Dr. Beadle when he was just on the wing for a hasty tour through Norway, Sweden, and as far north as Moscow. "At 4 o'clock in the afternoon on the Fourth of July," was the prompt reply, and at the day and hour named, our traveler set down his carpet bag at the appointed place. His power of observation was also remarkable. Though loyal to the sentiment of the wise man, "let thine eyes look right on, and let thine eyelids look straight before thee," yet he managed to give an immense circumference to his visual field, for riding over a stretch of country in a railroad coach, or passing through a hospital ward, and apparently occupied with inner thoughts, you would be surprised to find that the geological and floral peculiarities of the region had not been overlooked, nor had the different expressions of the sick escaped his notice.

Nothing perhaps would more quickly challenge the attention of one familiar with the career of Dr Beadle, than his early recognition as a public man Philadelphians have the reputation, I do not say justly, of being a *procul, O procul este, profanis* sort of people, a people proverbially slow to break over the charmed circle of family and sect, when sharing the responsibilities of public trusts Be this as it may, Dr Beadle, not long after his removal to this city, was elected a member of the Board of Trustees of the University of Pennsylvania. He was also a member of the active

Committee of the Philadelphia Society for alleviating the miseries of Public Prisons His interest was also solicited in behalf of the Institutions for the Blind, the Deaf and the Dumb He early became a member of the Academy of Natural Sciences and of the American Philosophical Society. That his connection with these different organizations was not simply nominal, will appear from the glowing eulogiums passed by several of these bodies upon the character, scientific and literary attainments of the man. And just here, let me say, in a parenthesis, that the disfavor expressed by many against ministers of the Gospel actively participating in public affairs, appears to me to be based on very narrow and erroneous views of the duties which belong to citizenship. The presence of an educated ecclesiastic among governing bodies, tends to leaven a large mass of crude humanity, and to transfuse it with a wholesome moral and restraining influence.

But great and varied as were his gifts and graces in literary and scientific knowledge, it was in the sphere of the ministry that Dr Beadle shone with a rare splendor God had eminently fitted him for this work. The office of the ministry is a very comprehensive one, including, as it does, preaching, pastoral labor, and attendance on church courts, and I know of no calling from which there is so much exacted. Between the demands of education, culture, secularity and sentiment, the minister is expected to embody all the learning of ancient and modern savants, all the refinement and polish of court circles, all the eloquence of an Apollos, all the meekness of a Moses, all the patience of a Job, and all the frugality and economy of a Franklin. I do not say that Dr. Beadle met all these requirements of the time, but he certainly approached the standards as near as most men of his profession. I am not sufficiently familiar with theological phraseology to express in technical language the characteristics of his preaching. The themes which constituted the subjects of his pulpit discourses were always evangelical, and managed with a consummate art The textual dissection or analyses of doctrine was conducted with a keen logical blade, and though embellished with great elegance of diction, and with a rare wealth of illustration, the central idea or doctrine always illuminated the foreground. A student of nature and of art, familiar with many departments of human learning, and master of language, he placed all the great acquisitions of his mind, gleaned from so many sources, under tribute in the discussion and enforcement of Gospel truth, which, while it challenged the undivided admiration of the ripest intellect, was at the same time leveled down to the capacity of a child As Madam Roland in her early readings of Telemachus and Tasso became so imbued with the spirit of her subject, that for the time, it is said, she was Eucharis for Telemachus, and Ermina for Tancred; and as Reynolds, that wonderfully gifted delineator of the human face, when contemplating the transfiguration of Raffaelle, became swallowed up in the resplendent glory of the scene, so there were times, when temporarily released from the pressure of physical weakness, that Dr Beadle, interpenetrated and enwrapped with

the high themes of his discourse, would be carried forward on a wave of impassioned, though self-possessed vehemence, that made him an embodiment of sweetness and power

The great and perplexing problem of the architect consists in making the crown of his edifice harmonize with, and not detract from its lower magnificence, and it is no uncommon experience to find a speaker sadly deficient in the art of rounding out an address, otherwise of the highest merit; not so, however, with Beadle, it was in closing perorations, when emphasizing the practical lessons of his subject, and appealing to the hopes, the fears, and the love of the hearer, that he captivated every avenue to the heart by a glowing fervor of impassioned rhetoric. How applicable to him are the lines of the Christian poet

> I venerate the man whose heart is warm,
> Whose hands are pure, whose doctrine and whose life,
> Coincident exhibit lucid proof,
> That he is honest in his sacred cause.

The petitions of this man of God were freighted with the necessities of universal humanity. His comprehensive love and catholic spirit embraced the entire race in all its multiform aspects Not alone the spiritual concerns of Zion, but with these all ranks and classes of men were borne to the mercy seat, on the wings of an imperial faith, in language glowing with supernal beauty and tender pathos, and from lips touched with the very fire of heaven. No one could hear Dr. Beadle pray without feeling that he had been down in the "garden of the beloved, among the beds of spices, gathering lilies and sweet-smelling myrrh."

When sickness or death entered the households of his parish, there was no voice like Beadle's. A large portion of his own life had been marked by physical suffering, and death had more than once invaded his home, bearing out of sight the treasures of his love, and as when the aromatic herb is crushed there comes forth its richest aroma, or as the fervid heat of the crucible separates the gold from the dross, so the naturally sweet nature of Beadle had been graced through the refining agency of physical and mental trials with a tender gentleness, which made him, in a peculiar sense, "a brother born for adversity"

That there was nothing perfunctory in his ministerial work, will appear from private memoranda found among his papers, showing how close to his heart lay the interests of his flock In these memoranda appear the names of individuals for whom special intercessions were made in private, and as these prayers were answered, and this one, and that one became connected with the Church, their places were supplied by other names. Some few of these appear to have been carried down for thirteen years or to the end of his pastorate, a circumstance, methinks, which would make the grave of Beadle appeal to these unsurrendered hearts with an eloquence more potent than the living voice

Much of the subtle magnetism of Dr Beadle's character was due to a

pervading sympathy which interpenetrated his whole moral nature. By this I do not mean the mere sentiment of feeling or of compassion Much more than this; something vastly more comprehensive, something in which both the heart and the head are concerned, and these two in such sweet harmony with man, in all his conditions, wants and aspirations, and with nature in all her moods, that unstudied, and instinctively the look of the eyes, the speech of the tongue, and the very manner of the body, all conspired in securing a supreme mastery over the human mind and heart. There is, perhaps, no position in which a minister of the Gospel can be placed that requires greater circumspection, to escape unfriendly criticism, than in discharging the claims of social life. Here he is brought into contact with the most incongruous elements of society, embracing the sober and gay, the reverent and irreverent, the learned and unlearned, the cultivated and rude Like his Master in company with the Scribes and Pharisees, "he is watched." Tried in this crucible, Dr. Beadle came forth without even the smell of fire on his garments. He could change the drift of distasteful conversation with consummate adroitness and reprove, without offense, by a silence more expressive than words His conversation, even on ordinary topics, was always entertaining, and generally, ingeniously concealed a golden thread of religious thought. Like the force of gravitation in the planetary world, attracting, yet at the same time keeping the celestial bodies at a fixed distance from the common center, so the transparent simplicity and purity of Dr. Beadle's character, while drawing every one to his person by a singular fascination, never encouraged undue nearness or familiarity.

It requires neither brass or marble to perpetuate the memory of a man like him whose life and character I have so imperfectly portrayed. His individuality was so impressed on human hearts that thousands to day behold his image as an ever present reality. The earth is covered with pretentious shafts, telling the story of ambitious men who once animated the sleeping dust beneath, but what inscription so noble! what one so brief and yet so comprehensive and glorious, as that which marks the gravestone of Beadle, graven at his own request—"*Only a servant of Christ.*"

A Collection of Words and Phrases taken from the Passamaquoddy Tongue. By Abby Langdon Alger.

(*Read before the American Philosophical Society, February 6, 1885*)

ā like a in father; *ī* like ee; *ch* as in German; *ū* like oo in spoon.

NOUNS.

Frog,	Tchkwūlsūk.
Dog,	Ūlehmūs.

NOUNS.

Turtle,	Chikquenocktsh.
Rabbit,	Māhtigwess.
Squirrel,	Mīko.
The ocean,	K'chīsōbequ'.
A chub,	Penobsqwess.
Sturgeon,	Possigūs.
My sister,	Nītzīkeshum. Netāq'.
My brother,	Sīwas.
My uncle,	Nitchaluqu'.
My wife (My old woman),	N'gusquessogsum.
My husband (My old man),	N'gītauq'uēmūm.
My spouse,	N'īsawīēk.
My father,	Mīthauksl.
My mother,	N'wīgūwis'l.
My aunt,	N'gaysis.
My grandmother,	N'ochgemiss.
My grandfather,	N'mochsims.
Young unmarried woman,	Nāksqu'.
Old maid,	Kakegīnāksqu'. Metatmenāksqu'.
A dollar,	Kūtāgesok.
Fifty cents,	Atāsegesūk.
Twenty-five cents,	Kaltlok.
Seventy-five cents,	N'hokaltlok.
Twenty cents,	Nisinsensūk.
A friend,	Nitchi, or Delnāben.
A man,	Senābe.
A flower,	Beskwaswesk.
A baby, Babies,	Wārsis, Wārsisuk.
A bear (Cub),	Mūin (Msqaouwessis).
A crow,	Kākāgūs.
A duck,	Sīps.
A deer,	K'Doch.
A chief,	Sogmo.
A firefly,	Pīsoquaysis.
Indian boy,	Tskinūsis.
Little girl,	Pilsquaysis.
Face,	P'saysūk.

NOUNS.

Your eye,	K'siskūr.
Your hand,	K'pītın.
A hair,	Pīāsūl. *Hair,* Piessōmul.
My ear,	N't'sōlkus.
My teeth,	Nībīt'l.
My forefinger,	N'telāwignix.
My fingers,	N'pētēnıl.
Your nose,	K'nīten.
My mouth,	N'tūm.
Life,	Poworgan.
A stone pipe,	Penābsquass.
A pipe,	Tomorg.
Tobacco,	Tomāwē.
Red willow tobacco,	Nespi Pomkwōl.
An axe,	Timhegan.
A ghost,	Kīsakbīsi.
A toy,	Amsqwojaygan.
A barrel of pork,	Bītssairway.
Sleep,	Kūin.
A cat, Cats,	Psuis, Psuısūk.
An eagle,	K'chīplāgen.
Woodchuck,	Mōninkwess.
A rock,	Penobsq'.
Whisky,	Hūkk'tāwitchtk.
Beer,	Kāwārdagūk.
A bottle,	Potay (bouteille).
A jug,	Pūkjinsquess.
A knife,	Mikwodārnıs.
My crooked knife,	M'kākanig.
Sweet grass,	Waylımihāsk'l.
Rain,	Kamīyūn.
Water,	Samawgwan.
A gull,	Kiāq'.
Moccasin–s.	Kūseni, M'kissun'l.
A tree, or wood,	Heppess.
A paddle,	Tā āgun.
A canoe,	Āquayden.
Smoke,	Kūtt.

Nouns.

The moon,	Nībauchsett.
The sun, also sometimes the moon,	Kīsus.
A wolf,	Molsum.
An Indian,	Skedzin.
The ground on which you sit,	K'takmekq'.
A basket–s.	Bassinode, Bassinodiel.
An owl,	Ko-ko-khas.
A house,	Wīnoksēgwan.
A tent, tents,	Wigwam, wigwaml.
Silver,	M'hān.
Lead,	Pīltār.
Birch bark,	Mosquay.
Umbrella,	Agwātayhaygan.
War,	M'tābecqu'.
A warrior,	M'tābegene.
Necklace,	Psikōsūn.
Earrings,	Sīgūsāhornal.
My ring,	Nāsāquaytāgūn.
Your bracelet,	K'pītinay.
A fur seal,	Hākeq'.
A star,	Ps'essm.
I,	Nīa. *My*, N'.
You,	Kīa. *Your*, K'.
A bow,	Tāb.
An arrow,	Bocqu'.
My bow and arrows,	N'tābocqu'.
Clothes,	Lūktiworgan.
My old clothes,	H'nkānay luktiworgan.
An old woman,	Pusquessus.
An old man,	K'tawquemus.
A spoon,	Amquon.
A needle,	K'sācott.
Thread,	Squasōntūk.
Legendary giant,	Kīwaq'.
Magician,	M'tayūlin.
Snowflake,	Kinēgan.
A leaf, leaves,	Mīp, mīpyil.

Nouns.

A fish, especially a herring,	N'meshis.
One,	Necq't.
Two,	Tābo, or nish.
Three,	Sīst, or nīhi.
Four,	Nao.
Five,	Non.
Six,	Cāmmātzin.
Seven,	Ellüwigenek, or niwijink.
Eight,	Okümultzin, or ügamitzin.
Nine,	Escünadek.
Ten,	N'tillen, or cüdensk.
Eleven,	Cüdankwo.
Twelve,	Nizanko.
Twenty.	Nizinsk.
One hundred,	N'cüdākq'.
A fan, fans,	Awāsahoso, awāsahosodien.
A porpoise,	Tchuspess.
Bread,	Abān (pone), or pānis.
Hasty pudding,	Sabaun (Suppawn).
Parched corn,	Psitmün.
A salmon,	P'laum.
A chair,	Kūtayboat.
A beaver,	Quābīt.
A fly,	Amüajalwes.
A butterfly,	Amawgessis.
A bug,	Āmüsquabīk.
Wampum,	Waubap.
A pin, pins,	Pinsis, pinsisük.
Meat, Flesh,	Wiouchs.
Hell,	P'lamkik.
Devil,	Mitchehānt.
God,	Kishioluqu'.
My mittens,	M'ljessük.
A woman,	Haypīt.
Snake,	Ātosis.
Wing,	Winisk, or Unaske.
Old silver ornaments,	Mānithbāk.
My silver flakes, or brooches,	N'spmān'l.

NOUNS.

A box,	Bāksis.
Ice,	H'nkūm.
Fire ashes,	Sqūdayawomqk.
Your tobacco ashes,	K'tūpquon.
Salt,	Solāwe.
A bird's bill,	Witūn.
Fish net,	Qwopīgun.
Your large fish hook,	Kichgun.
Your small fish hook,	K'ichgunnissis.
A bundle,	Wigūsūn.
Chocolate,	Pogārnop.
Meat soup,	K'sapwūhaygan.
Whip-poor-will,	Wippolis.
A white goose,	Wābekayloch.
A cane, or stick,	Abdehōn.
An iron nail,	Chissukhēgon.
My finger nail,	Nikūs.
An egg,	Wāwun.
A brass kettle,	Skezosis.
A bake, or pack kettle,	Tobānkāgan.
Charcoal,	Mūkkus.
Strawberries,	M'skēquīmensuk.
Raspberries,	Minsissuk.
Blueberries,	Śārtīl.
Maple sugar,	Sināwe sugel.
Coffee,	Kāppay.
A bit of bread,	Kegesko pānis.
A ball to play with,	Hēbesqwūmāgan.
Pin cushion,	Pinsīsīnote.
The Aborigines (almost considered in the light of Divine beings),	Kansūsuk.
The sable,	Nemauchswess.
The blind worm,	Wīwillmekq'.
Mermen,	Lampegwīnosis, or Hāpodampquen.
Raccoon,	Hespuns.
Handkerchief,	Kisquayp.

NOUNS.

Otter,	Kiūny.
Weasel,	Segwess.
Clam,	Hess.
Mosquito,	T'sīs-o.
My deer skin,	N'dochkwaio.
Wind,	Witchauksen.
Skunk,	Abekthēlo.
Sharp tool, used in making canoe,	Willicockskataygn.
Fog,	Biskūan.
My cap or hat,	H'ntāsosūn.
Dye,	Jisayg'n.
Any liquid,	K'sāp.
Muskrat,	Kīuchūs.
Fir balsam,	Poo-pook-kawiqu'.
Roaring lion,	Pītālo.
Loon,	Āgwem.
Beads,	Wīnokwopsqwees'l.
Snow shoes,	Agāmūk.
An old game, played with counters,	Alttestāgenūk.
The dish in which it is played,	Wāltāahmorgan.
The curved stick used in counting,	Nānodamegaywatch.
Three little sticks,	Lucktolem.
Little stick, *sticks*,	Hagaytamagin-al.
Big stick, *sticks*,	T'k'mwayway-al.
Charms to bring good luck in playing this game,	H'laylūk (Run down hill like water. Addressed to the counters.) Youtiligwayuch (Good luck come this way.)
Indian picture writing,	Kopsq'.
Cover of a basket,	B'-hāsūk.
Heron,	Kāsq'.
Lobster, *lobsters*,	T'sāk, T'sāgeik.
Medicine,	N'bēzūn.
Scissors,	T'sēgēhēgan.
Broom brush,	T'mispinahōna.

Nouns.

My dress,	N'dubsqwums.
The blackbird,	Chūkalisqu'.
The Spirit of the Night, or Ghost of Death.	Getauchs.
To-morrow,	Saybāonūk.
Yesterday,	Oolāgo.
Monday,	Agīsānde (First working day).
Tuesday,	Nīsēwaylūkan (Second working day).
Wednesday,	Haybāsigdul (Cut the week in two).
Thursday.	Ūstaywin (Day of the Supper).
Friday,	Skāwāhtūk (Day of the Cross).
Saturday.	Ketawasandūk.
Sunday,	Tegays.
Eastport,	Musaleqū.
Campobello,	Aybogwheat.
Friar's head (a rock at Campobello),	Skedabaysūkpenobsq' (Place of the Rock man).
Peter Dana's Point (an Indian village),	M'dākmaygūk.
Pleasant Point (an Indian village),	Sibāyk.
Bright eyes,	Pisawk'heksiskol.
A great hunter,	Gechīgedunk kīwīn.
The birds,	T'sipsaysūk.
Wildcat,	Pogum'k.

Verbs, Adjectives and other Parts of Speech.

Strong,	Sāglayū.
Naughty,	Ps'getqūn.
Smart,	Nikūsanīmā.
Full,	P'sūnpay.
Below,	Lamiūch.
My,	Nila, abbreviated to N'.
Your,	Kila, abbreviated to K'.
Pretty,	Kālousis, applied to things.
Pretty,	Oolaygo, applied to people.

Verbs, Adjectives and other Parts of Speech.

Good,	Kāloūt.
Bad,	Kōwōte, Mitchaygo, Mishaygan.
Red,	M'quayou.
Blue,	Enegwotte.
Black,	M'gsēwēyou.
White,	Wārbayou.
Yellow,	Wīsāwayou.
Green,	Skebgwotte.
To scalp,	Sāgātucht.
Little,	Absegilsis.
Big,	Nādāmughayl.
To talk,	K'didlawesk.
Candy, anything sweet,	Willipoget, or Moquannipoget.
Sour,	Sūāpoget.
And,	Niāga.
Cold,	K'taiūl, K'taiūk.
Warm,	Kisaywaygūk, Kisāwayou.
Very cold,	Wisagetkayou.
Fat,	Wickaywayou.
I am cross, *Cross, ill-tempered*,	N'jakmixo.
Quiet,	Wantigayou.
Above,	Spemūk.
Across,	Hāgāmin.
Round,	P'taygwārgīn.
Dark colored,	Mekswiouche.
To put,	Ponēmon.
To see,	K'nmaytūn
Very much,	Wīsagaymoch.
Too bad (compassion),	Mitaywayou.
Not much,	Kataquīn.
Cheap,	Kamasāōdū. Ulowadūl.
Dear (too much),	Sam āoudo.
Very soon,	Nikesaiūtay.
Busy (are you busy),	K'nōtamelok.
To buy,	Minochamen.
To hurt oneself very much,	Mnisīgikdeksīn.

Verbs, Adjectives and other Parts of Speech.

I fall down, *To fall down,*	N'qwastēsin.
Sick,	K'sīnoch.
So many. A great many,	Haypayjik.
To laugh,	Siktaylum.
Funny,	Wikwīnāgūt.
Very hard (to learn or say),	Sīgīwītāsūl.
Shy,	T'kwaysūch.
Rich,	Willywīgo
Broad,	K'skaiū.
Narrow,	Tchitcheegwaioo.
Very ancient,	N'kansūsūk.
Crazy,	Unādāmīny.
Sharp,	K'sīhīgin.
Thick,	Bārsayou.
Enough,	Naytā.
Me, my turn,	Naylā.
You, your turn,	Kaylā.
A great many,	K'tchīāwīū.

Phrases.

How do you do?	Bīqwonocksīan?
Fine day, good day,	Wāhlgesket.
Bad day,	Mitchigesket.
Good luck to you,	Kūlaylermūkq'.
How much is that?	Tān l'āoudo?
It is too dear,	O Sām āoudo.
It is too or very cloudy,	Sam eltor ālōk.
Too much sun, it is very sunny,	Sam eltor kīsūs.
Thank you,	Willyūn.
What's the news?	Tān lī tārhūt?
Tell me a story,	Ātokhāgin.
Have you got?	K'tīn?
Go away,	Pārlay lōs.
Keep quiet,	T'san kīūp.
What do you call that?	Kekīutkthlīwitmen?
What is your name?	Kekkthlevis?

PHRASES.

I see you,	K'nay mayōl.
Far off, distant.	Bītsārdok.
Yes,	Aha.
No,	Kedām.
I have none,	Kā d'ma. Kedāma.
How old is —?	K'tīhan — Keshīgedin?
Will you go?	Keshilihānūp?
The sun is coming out,	So k'hed kīsūs.
It is clearing,	Mūsquit.
Will it; is it going to clear?	K'tī mūsquit?
Do you want?	Pāwārdamen, or Kilkpāwārdamen?
I want,	N' Pāwārdamen.
I like you,	K'mūsālel.
You like me,	K'mūsāle.
I like it,	K'mūsājen.
I am going to stay,	K'dīdjenness.
A long time,	T'sīpkiūch.
I am hungry,	N'gedochb.
I am very hungry,	Nuisgekedūp.
I am thirsty,	N'gespāss.
I want a drink,	N'gedūs'm.
Please,	Ūlaydehādemen.
Give me,	Maylen.
I hear,	Notamen.
I know it,	N'gesīsichdoch.
My dear,	Kmūsāsāwāgan.
Write me a letter,	N'gedūwiknek.
It is cold,	K'tayūk.
It is warm,	K'sārday.
I am very glad,	Nūlaydehas.
I am very sorry,	N'iskyin.
Come again,	Apspogejian.
I am glad to see you,	Nūlaydehas k'naymayōl.
I am glad I came,	Nūlaydehas n'bayjayi.
This is a pleasant place,	Ūlēnāgūt.
I have brought you a present,	N' payjiptūm kaydemīl.
I have worked hard all day,	N'sēgolok kaygiuk.

PHRASES.

Tell me,	Yehīn.
He told me,	Dīhōgan.
That's right, all right,	Ūlīya.
I am going away from here.	T'llīon, or N'ūje mājehānnīūt.
I am going to — (any place),	N'titimi.
It is too late,	Mītsīūch k'sam.
It is getting late,	Mītsīūch.
It is early (the sun is high),	S'pmūk tūjayte.
Early in the morning,	Spāssiwayou.
God bless you,	Kishiōluqu'chiviatkohchaiauqu'.
Remember me,	Mikwīd'hāmen.
Because of your beautiful eyes,	Wīdjūloehkolauch siskol.
Come back with the birds,	Abskaypayjiwijiyaāmen tsipaysūk.
Do you understand?	K'nistūwī?
What's the matter?	Tan k'tlessin?
Why don't you answer me?	Kayjiwīskātāsidaymiūn?
It thunders,	Pītārgik.
It lightnings,	Paysārqūessok.
It rains,	Kamīyūn.
It snows,	P'sān.
I am afraid,	N'sex.
He is afraid,	N'aylansex.
It is mine,	Nīla nil nit.
I like to talk Indian,	K'mūsājenoch skedzinowōdamān.
Good bye,	Addīo.
Come here,	Tskūopfs.
Come quick,	Skūee.
Come here, run quick,	Squeak sick.
No matter,	Katīgegwūlay.
What?	Kek kwūssay?
Sit down,	Ābīn.
How did you come here?	K'tān klī bayzian?
It is shady here,	Agwā so sūt.
Where is —?	Tāmā —, or Tāmā molliglel?
It is false,	Klōs kū.

Phrases.

I am going to pay you,	Kittywārbenkūl.
He is poor pay,	Mitchi benkay.
The sun is setting,	N' Kīhay.
The stars go away,	Māhjayhik p'sis muk.
Where have you been?	Tam a gōje?
Say that again,	Abtsaydaymon.
Can you talk French?	K'plets m'nādūk?
Can you talk Indian?	Koax kl'nādūk Skedzinawā-dūk.
He is going to play ball,	K'tī hībesqwūnhetāwūk.
What does that mean?	Keg wūnit kthlewitmen?
It is new, or Is it new?	Pīlay?
It is old,	N'kārnay.
Can you read wampum?	Hay gay ta mūin wābpāb?
Who is that?	H'nitūwayn?
What did you say?	Kay gwan tay dam?
Are you well?	Kilkūlay wīsageg wūlay?
This is the pin your mother gave me,	Wāgāgīgus n'tā pinsis.
Are you there? (inside house)	K'tīn lamygwon?
I forgot it,	Nonedayhāgin.
You are sick,	K'sīkenochka.
I am sick,	N'ksīnoch.
I am tired,	N't sūwatk, or N'sūwort.
I am very tired,	N'wīsagīsūwoch.
Go on, continue,	Wiwysaiouwess.
Willingly,	Gchtlal.
Do you want to sell, or have you got any silver flakes to sell?	K'tanquoitūn miskaman?
Very soon,	Nikesaiūtay.
The wind is rising,	K'tīn wichauksen.
Where is your father?	Tank mitauchs?
Where is your mother?	Tam a gay gus?
You will get rich,	Nūwilliwik.
Stay a little while,	Mākyaywūsktīn.
I will come again next week,	Aptchichinpayje, pem luk kemkil.

PHRASES.

Tell — to come over here,	Ke tī han —, k'pūn kitzian kols·
Is it all silver?	Psīsdaymānik?
In old times,	N'karnayū.
I am very cold,	N'goach.
I am warm,	N'gesayp'us.
I am sweaty,	N'dārls.
I'll take this one,	Kedaynickanemen.
You have no fire,	Kedāmusc't.
There is no fire,	Kedāmabobskit.
What time is it?	Kaygabūsquay?
I hear a noise,	Notamenmīdetāhqwā.
I don't understand you,	Kādāma k'nistoluk.
Come and play with me (in a game),	Skūee āmdayny.
I beat you,	T'hūmhay.
You beat me,	K'tumhol.
You count,	Agayss.
It smells sweet,	Ūlay mākkt'day.
You are bashful,	T'kwayss.
I have got,	N'dīn.
Can you make?	K'nītā wī tūn?
Do you want to sell?	K't'wan kwētūn?
You'll soil it,	T'kwogwetunchs, or T'kwokchegwaytūn.
Dirty,	Āgwōgwaysuk.
I am all alone,	N'kedochkayin.
I am tired of waiting,	Sīūskōwīhā.
I am very sleepy,	N'getox.
He is dead,	M'atcheny, or M'atcheniak.

Phrases and Words in the St. Francis Dialect collected by Abby Langdon Alger.

Silver flakes,	Āmiskābōn.
Rain,	Sogalūn.
A chair,	Tāsāquābū.
A crow,	M'kāsas.
Mosquito,	Pōkwūs.

Deer,	Nūlka.
It is cold,	K′t′kā.
It is warm,	K′sāpatā.
What's your name?	Kāgwīlīwīsy?
Where's your father?	Turnykā mītāgwuss?
Frog,	Tchqwuss.
Come here,	Nādūsā.
I have brought you something,	K′pādūmkāgwinwijikīā.
Do you want something sweet? (to eat.)	Tatch a waldam wollypogack?
Feathers,	Mīgūnūk.
Flower,	Besqwasowinel.
This is a pleasant place,	Ūlēnāmen.
Do you understand?	Wowtāwich?
Tell me a story,	Ānt lō kāwich.
Wild cat,	P′sūch.
Farther,	Awāsiwī.
Days,	Kiskol.
Many,	M′sāli.
A very nice one,	Kīnīūlīgun.
A carpenter,	Nojikkāt.
The others,	K′dāgik.
And,	Tā.
A boy,	Oskinnomā.
My sister,	N′misis, or wītsīkāsūk.
Ear,	Tāwoq′.
Rocks,	Senal.
Blackberries,	Psakūdāmenāk.
Grass,	Pskikū.
Raspberries,	Sīkwūskimenak.
Blueberries,	Tsātān.
Butterfly,	Āhmitcholas.
Handkerchief,	Mūs wā (Mouchoir).
How do you do?	Bāqwonocksīu?
Friend, or brother,	Nitchia.
The sun is warm,	K′sapsū kīsus.
The sun,	Kīsūs.
A rogue,	Ātāgamqua.
Think of me,	Mīqwalmīnia.

A pleasant day,	Wūlges kat
A tree,	Habbāsy.
How much is it?	Tanīlāwādo?
It is too dear,	Sam awārdo.
Partridge,	Pārkaysuch.
A fox,	Unkwisis.
It is going to clear,	Bākūsāo.
Pretty,	Wūlīnā gwot.
A basket,	Ābāsāaodā.
Blue,	Wūlawīguk.
Green,	Skāskwīguk.
Yellow,	Wisawīguk.
Red,	Mākwīguk.
Black,	Pkāsāwegun.
White,	Wābegun.
Small,	Pīyousessoch.
Big,	Psīgain.
A fly,	Ūjarwass.
A big species of seal,	Lewārk.
A bee,	Wāhwillamūak.
Beads,	Nunpkewarna.
Mother,	Nīkowuss.
A friend,	Nītowba.
Are you asleep?	Kowykia?
Not at all (no thanks needed),	Dākāgwey.
Go on, continue.	Nikūnaksa.
All right,	Ūlīgun.
Salmon,	Spawmuk.
Cool,	Nūkāmuk.
Devils,	Mātahāntūk.

Supplementary remarks to the Grammar of the Cakchiquel Language of Guatemala, edited by D. G. Brinton, M. D. By Otto Stoll, M. D., of Zurich, Switzerland.

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Among the numerous branches of the great Maya family, the languages which form the Quiché-group (the Quiché with the

Uspanteca branch, and the Cakchiquel with the nearly allied Tzutuhil) offer a peculiar interest to the comparative philologist. These idioms have undoubtedly been long ago separated from the common Maya stock and may safely be reckoned among the oldest branches of this family. We may derive this fact not only from the geographical area they occupy in our days, but also from the changes which the languages themselves have undergone in the course of time. It is to be hoped that in a few years from now the lack of sufficient materials regarding them will no longer be an obstacle to rational etymological research, and that we shall be able not only to define the differences between the Quiché languages and the classic Maya, but even to trace out the laws, according to which these differences have realized themselves

At present, only a few hints can be given in this direction. With respect to the Cakchiquel in particular, its present stock of words seems to be formed by three different groups.

First, we find a group of words which have perpetuated themselves unchanged since the Cakchiquel became independent of the Maya. Such are the following :

ah, cane, grass.	*balam*, tiger.
al, heavy, weight.	*chi*, mouth.
am, spider.	*mam*, grandfather, etc.

NOTE 1 : In many words the difference between Maya and Cakchiquel is no real one, but must simply be attributed to the alphabets in which the two languages are written. So are the following Maya words : *iɔin* younger brother, *amac* inhabitant of a great village, *bac* bone, *cux* heart, life, identical with the Cakchiquel words : *i4,in*, *amaꜫ*, *bak*, *qux* or *ꜫux*, both in meaning and pronunciation, though different in orthography.

NOTE 2 : We may range among the first group a number of words in which the Cakchiquel has added a final *y* to the Maya root as in :

MAYA :	*ba*,	mole	. CAKCH : *bay*.
	be	way, road	*bey*.
	chho	mouse	*qhoy*.

NOTE 3: In some other instances there occurs an interchange of vowels between the two languages as in:

MAYA:	*zinic*	ant	CAKCH: *zanic.*
	miz	to sweep	*mez.*
	uinic.	man	*uinak.*
	cimzah	to kill	*camizah.*
	hol	the hole	*hul*, etc.

The second group is formed by words in which certain *consonants* of the Maya root change into other ones in Cakchiquel. These changes follow regular phonetic laws and bear a strong affinity to the principle of "Lautverschiebung" (Grimm's law), long ago known as an agent of most extensive application in the morphology of the Indo-germanic languages.

So the Maya *n* in many instances becomes *h* in the corresponding Cakchiquel root: the Maya *t* changes into *ch* in Cakchiquel and, as Brasseur de Bourbourg already remarked, the Maya *y* sometimes becomes *r* in Cakchiquel and its sister languages.

The following examples may serve to illustrate these changes:

A. The Maya *n* becomes *h* in Cakchiquel:

MAYA:	*kin*	the sun	CAKCH: *ɛih.*
	caan	sky	*cah.*
	can	four	*cahi.*
	on	the aguacate*	*oh.*
	uun	paper	*vuh.*
	nal	ear of corn	*hal.*
	xanab	sandal	*xahab.*
	zinan	scorpion	*zinah.*
	bolon	nine	*belehé* (in composition *beleh*).
	lahun	ten	*lahuh*, etc.

B. The Maya *t* changes into *ch* in Cakchiquel:

MAYA:	*ta*	obsidian	CAKCH: *chay.*
	te	tree	*che.*
	tub	saliva	*chub.*
	tuh	rotten, putrid	*chuh* (pus)

* The fruit of *Tersea gratissima.*

MAYA: *tun*	stone	CAKCH:	*chun*(limestone).
taan	ashes		*chah*.
tah	fir-tree		*chah*, etc.

C. The Maya *y* becomes *r* in Cakchiquel:

MAYA: *cay*	fish	CAKCH:	*car*.
koy	sperm		*ꜩor**
yax	green, blue		*rax*, etc.

Future inquiries will lead us to the discovery of the strict laws which rule the etymological affinity between the various branches of the Maya family. Here I must limit myself to the above given examples which may show the reader that such phonetic laws really exist and, I may add, that a similar "Lautvershiebung" can be shown between the languages of the Mam-group on one side, and the Maya and Quiché languages on the other.

Thirdly, there remains an extensive amount of Cakchiquel roots which do not seem to bear any direct alliance to the Maya words, but to have sprung from a distinct source. Most of these roots also occur in the two remaining groups of Guatemala idioms, *i. e.* in the Pokonchi and the Mam languages. After having got better acquainted with all the languages of Maya origin, we may undoubtedly hope to reduce the number of roots which now form this third group, to a considerable extent, and to discover affinities which, at present, are hidden. We shall even be able, perhaps, to point out the elements, which previously were strange to the Maya, and form the last remains of idioms preceding the Maya invasions in Guatemala.

After these short introductory remarks I shall proceed to comment on the "Grammar of the Cakchiquel Language" with a few notes, to which I had been invited by its learned editor.

p. 7. Introduction. "Cozumelguapam." The orthography now generally adopted in official papers and maps in Guatemala is *Cotzumalguapam*. The name is evidently of Nahuatl origin, and means, according to Buschmann,† *near the rainbow water*, from

* *ꜩor* is the usual word for *atole*, a beverage made of corn and sugared water.

† Buschmann, Ueber die aztekischen Ortsnamen, p. 799.

cozamalotl. Though this etymology does not seem entirely satisfactory, I cannot offer any better.

p. 8. "*Cakix*, the ara or *guacamalla*, *Trogon splendens.*" The bird called "*cakix*" by the Indians is the *Ara macao L.* known generally by its Carib name *guacamaya.* *Trogon splendens* is a scientific synonym for the *quetzal*, *Tharomacrus mocinno* (Lall.), a bird differing widely from the ara both in shape and color.

p. 19. *Phonology.* The four new signs added to the European alphabet by some of the old writers on Cakchiquel (Parra, Flores) *viz:* ꜫ, ꜭ, ꜯ, ꜭh are but phonetic modifications of four corresponding signs of the common alphabet. So we get four pairs of sounds, namely:

c and ꜭ;
k and ꜫ
ch and ꜭh
tz* and ꜯ

forming two series of consonants, the former of which represents the common letters, and the latter their respective "cut letters," which may be described as being pronounced with a shorter and more explosive sound than the corresponding common letter, and separated by a short pause from the preceding or following vowel.

p. 21. *Declension of nouns.* *vleuh*, earth, pronounce *uléuh.* In the old Spanish grammars the *v* before a consonant is always an *u*, before a vowel it has the sound of the Spanish *v.*

yxok. The old writers are very inconsequent in the alternate use of *y* and *i*, and the reader might be misled so as to suppose them to be two differently sounding letters. Wherever in the old grammars *y* precedes a consonant, it sounds like the common *i*, and so we write better,

ixok	instead of	*yxok.*
ix		*yx.*
itzel		*yꜩel*, etc.

In all plurals ending with *y* with the old writers, it has always the sound of *i*, and bears the accent. In pronunciation it is separated by a short hiatus from the preceding vowel and does

*ꜩ is simply an antiquated form of the German tz, and is pronounced exactly like it.

not form a dipthong *ay*, as one would believe from the old orthography. So read

mebai	instead of		*mebay.*
ahtzeolai			*ahtzeolay.*
ahpitzolai			*ahpitzolay,*
tzatchi vinak		read	*tzatzi* vinak.

p. 22. *aqual*, *aquala*, child, written, according to the old Spanish orthography, for *acual*, *acuala*. Many Indians pronounce *a4ual*, *a4ualá*.

p. 23. *zah* read *zak* white.

coman *çaman*, or *zaman* the cornfield.

camah *çamah* or *zamah* to work.

chu4huh *4hu4huh*, *4hu4huhilah.*

gix, *gixalah* thorn, thorny, read *4ix* *4ixalah.*

4, echelah ticon, a cacao-field neglected and overgrown; most probably an error of the copyist for *4ichelah* t.

qul (*4ul*) is the "manta," the unworked cotton-cloth.

Ꜫu is the "chamarra," a sort of woolen blanket used by the Indians.

p. 24. *hai* read *háy*, because here the *i* forms part of a diphthong *áy*.

nu uh, *nu uhil*, write and pronounce *nu vuh*, *nu vuhil* my book. If the root were simply *uh*, its combination with the possessive pronoun would be *v-uh*, and not *nu uh*.

zac, *zacil* is the orthography adopted for the pure Maya idiom. It corresponds with the Cakchiquel *zak*, *zakil* (also *çak*, *çakil*).

p. 25. *chu vih* "against me," *v-ih* means "my back," *chu vih* at my back, behind me. And so *cha vih*, behind thee (not *chahvih*).

p. 26. *chinubilvih.* Flores gives the same combination (p. 255) with the variant *chirubilvih*, within himself. He adds another one of the same meaning, formed with *cohol*, the space or distance between two things, viz.: *chinu cohol* within myself.

cha cohol within thyself.

chu cohol.

chika cohol.

chi cohol.
chıquı cohol.

viquın. More consistent with the real pronunciation is Flores' orthography *vuꜭın* vel *vıꜭin*, with me.

auꜭın vel *auıꜭın* with thee.
ruꜭın *rıꜭin.*
kuꜭın *kıꜭin.*
yuꜭın *yuıꜭın* (pron. iviꜭin).
cuꜭın *quıꜭın.*

p. 27. *nu ꜫahol* my son, read *nu ꜭahol.* *ꜫahol* is he who breaks something.

nu nımıal my elder brother, read *nu nımal.*

p. 30. *Quis vel quı, who?* Flores treats this matter in his § 4, pp. 47 and 99, according to his views of the Cakchiquel grammar, as follows:

Nomınatıve: nak vel *anak* vel *achınak.*
who who who.
nakı who or what?

Genet. : *achok* vel *nakchok.*
whose whose.
achokychin *nakchokichın.*
whose whose.
ahchok whose.

Datıve: nak chırıkın vel *chire.*
to whom.
nak chıquıchın vel *chique.*
to which of them.

Accus.: nak xacamiçah.
Whom didst thou kill?
nak chırıh xaꜭholıhvı.
With whom didst thou quarrel or fight?

Ablative · *nakruꜭın*, *achokrıꜭın.*
with whom.
nak rumal.
by whom, or by what.

QUICUNQUE VEL QUIVIS.

Any one whosoever.

To these correspond the following: *Nak* vel *naklaꜭa* vel *bilachinak*, and their meaning is any one, whosoever.

v. g. Any one that will not obey, will be punished, *nakla mani xtiniman xti4ahiçax ruvach.*

ALIQUIS.

For aliquis is used the verbal root *4oh* which signifies: to be somewhere (Spanish, estar), v. g. *4oh xbano* some one did it. Also, *bila*, *bilanak*, *bilachinak* are used for the *aliquis*, f. i. *ve bila x4amo hoyeruvach*, if some one has taken it, woe to him. *Bilanak* or *balanak chi yabilal*, *bilanak chi ʒaxomal*, some of the infirmities, some of the pains. *Ve bila tux chivichin eleʒon xtirapax*, If some one of you is the thief, he will be whipped.

So far Flores. It is almost superfluous to say that there does not exist anything like declension of interrogative pronouns and the like, and that a future analysis of the above given expressions will show in how many respects they thoroughly differ from the Latin *quis*, *quicunque*, *aliquis*, etc.

p. 31. Distributive words.—Flores adds (p. 31): "For the distributives of a number they use the particle *ychal*, postponed to the numeral, and the possessive pronoun before it."

CAY, the *y* changed into *b*: *cab*.

Sing. *ru cabichal* both of them.
Plur. *ka cabichal* we both.
y cabichal you both.
qui cabichal they both.

OXI.

Sing. *roxichal* all three.
Plur. *koxichal* we
yvoxichal you } three.
coxichal they

CAHI.

Sing. *ru cahichal* all four.
Plur. *ka cahichal* we four.
y cahichal you four.
qui cahichal they four. And so forth.

p. 32. *nuion*, etc. Flores writes, consistent with the real pronunciation, *nuyon*, *ayon*, etc.

Chapt. III. Of the Verbs.

An exact study of the Maya and Cakchiquel verb would lead us too far at present, and so I am obliged to follow this difficult, but interesting matter according to the system adopted by the old grammarians.

Sum, es, fui.

Flores (p. 68) is of opinion that the verb *ux* in some instances means to become, *fio* being a kind of passive of the active verb *ban*, to make, but that there are other instances where it supplants the true verb sum, fui, esse, f. i. in *nak tux*, who is it?

Flores gives the conjugation of the verb *ux* as follows:

Preterit perfect.

in ꜫinom xinux	I have been rich.
at ꜫinom xat ux	Thou hast been rich.
ꜫinom xux	
oh ꜫinoma xoh ux	etc.
yx ꜫinoma xix ux	
he ꜫinoma xe ux	

Future imperfect.

In ahtih xquinux	I shall be a teacher.
at ahtih xcat ux	Thou shalt be a teacher,
ahtih xtux	etc.
oh ahtiha xkoh ux	we shall be teachers.
yx ahtiha xquix ux	
xque ux	

It is easy to see that the root *ux* is conjugated according to the rules of the passive verbs, and its present, which no grammarian gives fully, would be *quin-ux, cat ux, tux, koh ux, quix ux, que ux.* We may even venture to see in the suffix *x* the true sign of a passive verb "to become," and to consider *ux* as the passive of a hypothetical active verb *uh*, to generate, and to translate the above given examples accordingly: I have got rich, I shall become a teacher.

p. 34. Imperfect preterit.

yn naek utz, I was good. Flores says: "In this idiom there is no special word for the said preterit and for forming it, we

want a temporal sentence: I was good when thou camest. *In utz, tok xatul*, etc." He adds (p. 62), "With less than a temporal sentence the said preterit cannot be expressed, because forming it with *naek* as some Artes MSS. do, is but imperfection, as is shown by the formation of the said particle, the meaning of which is: though, but. Notwithstanding everybody may conform himself with the style of his place."

Perfect preterit. Flores forms it with *ux: in ꜭinom xin ux* I have been rich, etc., but he gives also: *in oher ahau* I have been chief.

Pluperfect. Flores gives:

	xax in vi ꜭatolꜩih	I had been judge.
	xax at vi ꜭatolꜩih	Thou hadst been judge, etc.
and:	*in ok utz*	I had been good.
	at ok utz	Thou hadst been good.

p. 37. *chuhach* read *chuvach.*

Optative Mood. Imperfect preterit. Flores (p. 72) gives:

In tah naonel quinux I would be heard or understood.

Preterit perfect. Flores (p. 73):

in tah utz uxinak I would have been good (Yo haya sido bueno).

Preterit pluperfect. Flores (p. 74):

xatavi in utz, etc. yo huviera, havria ó huviesse sido bueno.

Infinitive Mood.

Besides the *present* and *imperfect tense: in tah utz tivaho* I want to be good, Flores (p. 78) gives the *preterit perfect* and the *pluperfect* as follows:

Sing. *In ta meba xinux can tivaho.*
yo quisiera haver sido pobre.
At ta meba xatux can tavaho.
Tu quisieras haver sido pobre.
Meba tah xux can tivaho.
Plur. *oh ta mebay xohux can tikaho.*
yx ta mebay xixux can tivaho.
he ta mebay xeux can ticoho.

From all the named differences between the old authors in their elaboration of the Cakchiquel paradigm for the verb sum, fui, esse, through all its moods and tenses, the reader will satisfy

himself, that this verb does not form any inherent part of the Cakchiquel, but has been artificially built up by the priests by various particles and circumlocutions.

p. 40. Indicative Mood of the verb ꜭoh.

Negative preterit imperfect. Flores (p. 82):

Tan in mani ꜭoh
vel *mani in ta ꜭoh*, etc.

p. 41. Flores gives a *Preterit perfect.*

utzta xiꜭohe tah, yo haya estado
utzta xatꜭohe tah, tu hayas estado.

Gerunds. In following up his system, Flores (p. 97) adds what he singularly calls an *Accusative Gerund*, formed with the verb *be* to go.

quibe ꜭohe, voy á estar.
catbe ꜭohe, vas á estar, etc.

and an *Ablative Gerund.*

tan ok in ꜭoh, estando yo.
tan ok at ꜭoh, estando tú.

He adds a participle of the present (p. 98): *ꜭohl*, el que está.

Pluperfect.

Were we to adopt for a moment the views of the old grammarians about the Indian verb and to form a pluperfect, it would, with the root *ban* to make, for instance, run thus:

nu banun chic, I had made.
(verbally : my making already.)
a banun chic, Thou hadst made, etc.

Flores forms it with the verb *loꜫon*, to love.

nu loꜫ om chic, I had loved.

The same form *nu loꜫ om chic* he gives for the Future perfect, I shall have loved, which shows that no such thing as a Future perfect does exist in Cakchiquel.

yn loꜫ oninak (correctly formed from the intransitive verb *loꜫ on*), I was he who loved.

p. 45. *tivulicah* read *tivuliçah* I cause to come.
tivutziricah read *tivutziriçah.*
p. 51. *xoꜫ ohauh* read *xokahau.*
p. 55. *oh ahtih*, etc. read *oh ahtiha*, etc.

p. 58. Verbals in om. When combined with the possessive pronouns they serve as preterit perfect; *nu banom* I have done.

p. 59. Of Certain Pronouns.

This matter is more extensively treated by Flores (§ XIV, p. 209 sqq. De las oraciones de accusativo) and he gives the following Paradigms:

PRESENT.

quin a		Thou lovest me.
cat nu		I love thee.
ti nu	*loꜫ oh*	I love him.
koh y		You love us.
quix ka		We love you.
que ka		We love them.

PRETERIT.

xin a		Thou hast loved me.
xat nu		I have loved thee.
x nu	*loꜫ oh*	I have loved him.
xoh ru		He has loved us.
xix ka		We have loved you.
xe ka		We have loved them.

FUTURE.

xquina		Thou shalt love me.
x cat nu		I shall love you.
xti nu	*loꜫ oh*	I shall love him.
xkoh y		You shall love us.
xquix ka		We shall love you.
x que y		You shall love them.

PRETERIT PERFECT.

in a		Thou hast loved me.
at nu		I have loved thee.
ha nu	*loꜫ om*	I have loved him.
oh ru		He has loved us.
yx ka		We have loved you.
he y		You have loved them.

Of course, the number of possible combinations between subjective and objective pronoun in the verb is not exhausted by the given examples.

As for combinations of verbs with negative or vetative adverbs, Flores gives the following examples:

ACTIVE VERB BEGINNING WITH A CONSONANT.

min		no haga yo.
ma		no hagas tú.
mu	*ban.*	no haga el, etc.
maka		
mi		
maqui		

ACTIVE VERB BEGINNING WITH A VOWEL.

miu		no oiga yo, etc.
mau		
mar	*aꜭaxah*	(to hear)
mak		
miu		
mac		

ABSOLUTE, PASSIVE AND NEUTER VERB BEGINNING WITH A VOWEL.

min		
mat		
ma (vel) *m*	*aꜭaxan*	(absolute) to hear.
moh	*aꜭaxax*	(passive) to be heard.
mix		
me		

VETATIVE ADVERBS FOR IMPERATIVES OF NEUTER, ABSOLUTE AND PASSIVE VERBS BEGINNING WITH A CONSONANT.

min		
mat		
ma (vel) *ba*	*var*	to sleep.
moh	*loꜫ on*	to love.
mi (vel) *bi*	*loꜫ ox*	to be loved.
me		

p. 62. *qu que* to sit down. Better write *quqe.* The word is often pronounced cuke and quke.

The system of conjugation in the idioms of Maya origin needs a thoroughly renewed study. The first step will be to examine by a comparative study of the various branches of the Maya family, if the syntactical elements, commonly called verbs, can

really be considered as true verbs. Then we must try to clear them of all the artificial additions of the priests, and to find out the real Indian verb and all its possible forms, tenses and moods, a task by no means so easy as it would seem from a superficial examination. In a subsequent publication, I propose to enter more fully upon this theme.

On the Embryology of Limulus polyphemus. III. *By A. S. Packard.*

(Read before the American Philosophical Society, January 16, 1885.)

The stage under examination is that represented on figs. 12 and 13, 14 and 15 (Plates iii and iv), of my essay on the development of Limulus, Memoirs Boston Society Natural History, 1872. At this stage the oval blastodermic disc, with the six pairs of the cephalic appendages, is distinctly formed; the mouth is seen in a position in front of the first pair of appendages, and from it the primitive streak passes back to the posterior margin of the blastodermic disc or "ventral plate" The abdomen is separated from the head by a curved groove, as seen in fig 12, of my memoir.

I should here remark that the eggs were not fresh, but selected from a number kindly collected for me in 1871, by Rev. Samuel Lockwood, and since then preserved in alcohol, which had been renewed several times, my studies on the embryology of this animal having been interrupted from year to year, in hopes of obtaining fresh eggs, and for want of good thin sections of those I already had. I finally applied to my friend Dr. C. O Whitman, whose great experience in making delicate sections was kindly placed at my disposal, the sections examined were actually made by Mrs. Whitman, under the direction of her husband. The period examined is an interesting one, as while the cephalic appendages were well-developed, the abdominal appendages were not as yet indicated, nor the post-oral nervous ganglia

The first point, which at once excited my attention, was the nature of the embryonic membrane which I had previously regarded as the homologue of the amnion, and afterwards as the serous membrane of insects, but which Mr. J. S Kingsley* has found to be secreted from the blastoderm. That he was correct, and that I was in error in regarding it as truly cellular, was at once seen to be evident. A thin section (fig 1 and 5), shows that the membrane is very thick, structureless, the cellular appearance being confined to the external surface. This membrane is evidently secreted by the blastoderm; the irregular cell-like markings (see my second memoir, 1880, Pl iii, figs. 14, 14*a*, 14*c*, 14*d*), are, so to speak, casts of the blastoderm cells, which with the marks of even their nuclei are impressed upon the

* The Development of Limulus, Science Record, ii, pp. 249–251, Sept., 1884.

membrane during the early stage in its formation, after a while new matter is added to the interior which is structureless, so that the cellular appearance is only superficial. In my comparison of this membrane with the serous membrane I certainly exaggerated its resemblance to the *serosa* of insects, as the latter is a much more delicate membrane, and with a characteristic appearance in Crustacea, the scorpion, myriopods and hexapods. The membrane in question appears to have its homologue, however, in the embryonic membrane of Apus, which we have described in a foot-note on p. 161, of our first memoir. It thus appears that this supposed point of resemblance in Limulus to the Tracheata is removed.

A longitudinal section of the embryo of Limulus is represented by fig. 2. The section passes through the blastodermic disc (ventral plate) and the indications of the appendages, on one side of the median line of the body. The epiblast entirely surrounds the yolk, forming a thin layer with nuclei, the cell walls not being distinct, while the nucleolus consists of a number of granules. The nuclei are two-deep only on the cephalic portion of the embryo. The blastodermic disc does not extend quite half-way around the egg. The six pairs of appendages are well developed, increasing in size from the first to the last pair. The mesoblast is now well developed, the nuclei well marked, but the cellular walls more or less effaced. The mesoblastic arthromeres are now well indicated. The somatic cavities are well marked in each appendage, the somatopleure is from one to three cells deep, the splanchnopleure is formed usually of two layers of cells, and is more or less continuous at the ends of the somatic cavities with the somatopleure. The relations of these divisions of the mesoblast, which are destined to form the muscles of the limbs and the ventral aspects of the body, are represented in fig. 3.

The mesoderm, as seen in fig. 3, is now differentiated into three sublayers. 1, the somatopleure; 2, the splanchnopleure, and 3, a sublayer from which probably arises, in part at least, the connective tissue so remarkably developed in the head of Limulus; in its thickest portion at this stage this innermost layer consists of about eight series of cells, which are more loosely arranged than in the sublayers next to the epiblast.

The yolk granules are minute, the largest granules not more than twice as large as the nuclei of the mesoderm. The hypoblast cells are by far the largest cells in the embryo, and at once attract attention by reason of their size, and their deep color when stained, the nucleus and nucleolus are well marked. At this stage no hypoblast cells could be detected in the yolk, nor any protoplasmic network connecting them. Those present formed a dorsal row ranged next to the thin epiblast over about one-quarter of the periphery of the ovum. In an earlier stage, however, the yolk granules are contained in distinct polygonal cells, forming a network extending through the yolk.

The abdomen has not yet undergone segmentation, the incipient steps are represented in fig. 2, where there appear to be arising five mesoblastic segments (1, 2, 3, 4, 5). Between the first and second mesoblastic mass

is a narrow cavity which sends a branch forward to the base of the abdomen, and a second obliquely downward and inward ; at 2 and 3 in fig. 2, there are narrow cavities or splits (somatic cavities ?) which communicate with a longitudinal internal opening, which extends in a direction parallel to the under (now outer) surface of the abdomen. In this respect the embryo of Limulus is very different from that of the scorpion and spiders (see especially Balfour's figs 5, 6, Pl. xix and fig. 15, Pl. xx), where the abdominal segments, with their appendages and somatic cavities are formed contemporaneously with those of the cephalothorax The innermost mesodermic cells are now arranged in long cords, destined to form the ventral adductor muscles of the abdomen

The mode of formation of the head and its shape at this time presents important differences from that of tracheate embryos The procephalic lobes are not developed ; the preoral portions of the head, *i. e.*, that part in front of the first pair of limbs is very small, short and narrow, merely forming the end of the oral blastodermic disc, seen in my earlier published figures. The structure of the preoral portion of the head (*procephalum* as we may term it), is seen in longitudinal section in fig. 3, *pc*, to apparently consist merely of an extension of the postoral part of the head, with apparently one or two splits in the mesoderm (ms^1, ms^2), the nature of which I do not understand, undoubtedly farther sections and comparisons will throw light upon it. There is no involution of the epiblast, and the section passes one side of the mouth, a good section of which I have not yet seen.

The first nervous ganglion is seen at fig 5, to result (as also first shown by Kingsley) in an ingrowth of the epiblast (*inv. c*) ; carrying into the interior a mass of epiblastic nuclei, which envelop the myeloid substance (*my*), which, as in older embryos, remains unstained by the carmine

The mesoblastic nuclei stop at a large cell (*c*), beyond which are long incipient loose muscle-cells, with a few scattered nuclei. The procephalum terminates abruptly, forming, as seen in our earlier figures already referred to, the end of the blastodermic disc

The absence of the procephalic lobes in the embryo Limulus of this stage seems to us to be a very significant fact, and to point to the early divergence of the Palæocarida from the stem leading up to the Tracheata, and especially the Arachnida. Metschnikoff's researches on Scorpio, with those of Claparède, and of Balfour on the spiders, and those of Sograff on the myriopods, show that this is a fundamental and early attained feature in these types. Their absence in Limulus shows how little its embryo has in common with tracheate embryos At the same time the general mode of formation of the blastodermic disc (ventral plate) of Limulus is much like that of the spider, as seen in the mode of origin of the mesoblastic segments, and the probable orgin of the hypoblastic cells. There is a superficial resemblance between the embryo of Limulus and of the spider, as may be seen by a comparison of our fig 2, and Balfour's fig 15. Without much doubt the Tracheata and Palæocarida, as well as Crustacea

Neocarida, branched off from a common ancestor, but the more important morphological points show that the terrestrial, air-breathing tracheates were a much later branch of the Arthropod tree than the marine branchiate Palæocarida and genuine Crustacea. Probably the Palæocarida (Limulus, Merostomata and Trilobita) were the earliest arthropods to appear, after them arose the Crustacea, perhaps at nearly the same time the Arachnida, and finally the Myriopoda and the winged insects. Without much doubt, the earliest branchiate forms were our Protocyclus,* the ancestor of the Palæocarida, and a Protonauplius form, the forerunner of the Crustacea; these were marine, perhaps branchiate organisms, with a few pairs of simple oar like swimming appendages either around or just behind the mouth, and which were free swimming or creeping forms, the Protocyclus was, perhaps a solid oval creeping animal living at the bottom on mud or sand. The branchiæ probably became first developed on the limbs of the free-swimming Protonauplii, as they needed, owing to their great rapidity of movement, the means of rapid aeration of the blood, while in the heavily-moulded less oxygen-consuming Protocyclus, the evolution of gills was somewhat postponed. The steps from Protocyclus to Agnostus was not a very long one. The oldest arthropods, notwithstanding the recent discovery of a Silurian scorpion, were trilobites.

The following conclusions are drawn from a study of the stage of Limulus here figured.

The fact that the embryo Limulus has at first no abdominal appendages (uropoda), whereas there are temporary abdominal appendages in the tracheates, shows that Limulus in this important respect has little in common with the Arachnida, Myriopoda or Hexapoda. On the other hand in the embryo Crustacea the cephalic limbs are first indicated, the nauplian limbs, as well as the zoëan appendages being cephalic; the uropods not appearing until after the Crustacea leave the egg

These facts indicate that Limulus probably descended from a type in which there were cephalic appendages only, and no abdominal appendages. The absence of a serous membrane, of an amnion, and of procephalic lobes, of temporary embryonic abdominal appendages (at the stage above described); also of protozonites (seen in the early embryo of the scorpion and spider) tend to prove that the embryo of Limulus has little in common with that of Tracheata

On the other hand the earlier stages in the embryology of Limulus resemble those of Crustacea in the absence of the procephalic lobes; in the primitive development of cephalic appendages alone, the comparatively early appearance of the branchiæ of Limulus in the stage succeeding that figured in this essay, shows that the Limulus probably never had any genetic connection with a tracheate arthropod.

On the other hand, the tracheate features of mesoblastic somites are also seen in the worms, in Peripatus and in Annelida.

*See Development of Limulus, 1872, p.

It appears that the embryology of Limulus is scarcely more like that of tracheates than Crustacea, it is a very primitive type standing nearer the branchiate arthropods than the tracheate, but on the whole should be regarded as a generalized or a composite form, which with its fossil allies, the Eurypterida and Trilobitæ, form a class by themselves with a superficial resemblance to the Arachnida.

It seems to us that the above mentioned characters, which separate the early embryo of Limulus from the tracheates, are as important, if not much more so, than those of the absence at first of an archenteric cavity or differences in the mode of origin of the mesoblast, noted by Mr. Kingsley in his brief paper on the development of Limulus In these general, primitive embryonic characters Limulus appears to be as nearly allied to the annelids as to the tracheates; and too much dependence should not, it seems to us, be placed upon them in seeking to establish the true relations of the Palæocarida among the arthropods. In the higher worms the two longitudinal mesoblastic bands split into somatic and splanchnic layers (Kowalevsky). In Mysis Metschnikoff states that the mesoblast becomes broken up into distinct somites (Balfour's Embryology i, 436). If so, then this character is not one of much importance to separate Limulus from the Crustacea. The ultimate origin of Limulus from the same stock as that which gave rise to the modern annelids seems not improbable.

EXPLANATION OF THE PLATE.

Fig 1.—Blastodermic cuticle (*bl. cut*) lying upon the epiblast (*ep*). The nuclei scattered through the latter, the nucleolus, in these as well as the mesoblast cells, consisting of a number of granules. $\times \frac{1}{8}$ A.

Fig 2.—Longitudinal section through an embryo before the appearance of the abdominal appendages, but after the rupture of the chorion, the section passes through the six cephalic appendages (i-vi), showing the somatic cavities (*ms*), the splanchnopleure (*sp*), and somatopleure (*so*), 1–5, the indications of the five primitive uromeres; *hy*, hypo or ectoblast $\times \frac{1}{8}$ A.

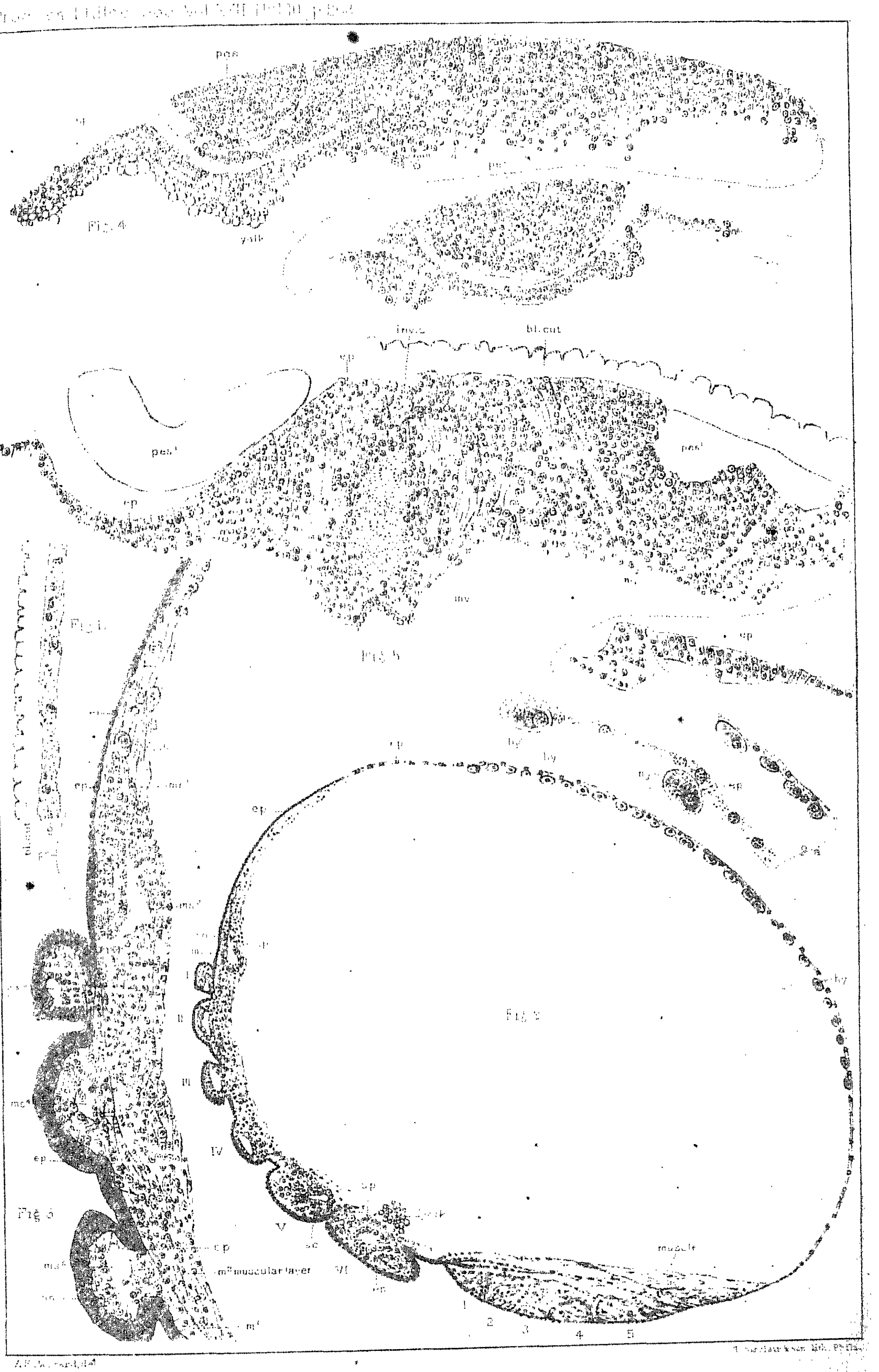
Fig 2*a*—Showing the relations of the hypoblastic cells (*hy*) to the epiblast (*ep*) in the dorsal region of the embryo.

Fig. 3—Longitudinal section of the head and the first three appendages; ms^1, ms^2, first and second somatic cavities in the preoral region of the head. This figure also shows the relations of the splanchnopleure and somatopleure to the epiblast. *c*, large distinct cell in preoral region. $\times \frac{1}{8}$ A.

Fig. 4.—Transverse section through the head, including the appendages. $\frac{1}{8} \times$ A

Fig 5.—Transverse section through the head, showing the invagination, and thickening of the epiblast to form the brain; *my*, myeloid substance of the ganglion. $\times \frac{1}{8}$ A.

All the longitudinal sections are from the same egg, and the transverse sections from another. The figures were all drawn by the author with the camera.



EMBRYOLOGY OF LIMULUS.

Stated Meeting, February 6, 1885.

Present, 14 members.

President, Mr. FRALEY, in the Chair.

Dr. Mallet, Dr. Parvin, and Mr. Hockley, new members, were presented to the Chair and took their seats.

Donations for the Library were received from the Royal Society of New South Wales; the Royal Central Institute of Meteorology and Terrestrial Magnetism at Vienna; the Geographical Society at Halle; the Royal Society of Northern Antiquaries at Copenhagen; the Royal Society of Science at Upsal; Flora Batava; the Royal Academy of Sciences, Letters and Fine Arts of Belgium; Dr. Giulio Carroti of Milan; the Bureau of Longitudes, the Zoölogical, Anthropological, Geographical, American Antiquarian Societies, the Society for Japanese Studies, the Ethnographical Institution, the International Congress of Orientalists, the Oriental Athenæum and Mr. Schœbel of Paris; the Musée Guimet; the Société d'Emulation of Abbeville; the Royal Academy of History at Madrid; the Royal Geographical, Geological, Asiatic, Antiquarian Societies of London; the Royal Institution; Victoria Institute; the Kew Observatory; London Nature; the Royal Dublin Society; the American Academy of Arts and Sciences; the Boston Society of Natural History; Prof. Charles A. Young; the American Philological Association; the American Journal of Science; Mr. Alexander Graham Bell; Yale College; J. W. Lovell & Co., Publishers, of New York; Dr. E. W. Syle; Prof. Henry Carvill Lewis; Lea Brothers & Co., of Philadelphia; Johns Hopkins University; Department of the Interior; the United States Civil Service Commission; the Light-House Board; the War Department; the Chicago Historical Society; the State Bureaus of Labor Statistics at Pullman, Ill.; the University of Michigan, and the Geological and Natural History Survey of Minnesota.

Letters of acknowledgment for Proceedings No. 116, and Reg-

ister of Papers, &c., were read from the Numismatic and Antiquarian Society of Philadelphia; Smithsonian Institution; Library Company of Philadelphia; New Jersey Historical Society; Pennsylvania Historical Society; College of Physicians; Connecticut Historical Society; Wyoming Historical and Geographical Society; American Antiquarian Society; Essex Institute; University of the City of New York; United States Naval Institute; Georgia Historical Society; Chicago Historical Society; the United States Military Academy; Cincinnati Observatory; Wisconsin Historical Society; West Chester Philosophical Society; New Hampshire Historical Society; Boston Public Library; Boston Athæneum, and the New York State Library; Prof. W. LeConte Stevens; Prof. Thomas C. Porter; Mr. Henry Phillips, Jr.; Prof. John J. Stevenson; Prof. C. H. F. Peters; Prof. J. M. Hart; Mr. Thomas Hockley (114, 115, 116); Prof. J. W. Moore (114, 115, 116); Kansas Historical Society.

Letters of acknowledgment were also read from Royal Society of Edinburgh (114 and 115); R. Instituto Lombardo; Statistical Society of London (115); Societas Fauna et Flora Finnica (107, 108, 113, 114, 115), asks for 109, 110, 111, 112.

Letters accepting membership in the Society were read from Prof. John W. Mallet, Prof. William Osler, Prof. Samuel W. Gross, Prof. James C. Wilson, Prof. George Inman Riché, Hon. George L. Harrison, Hon. Samuel J. Randall, Mr. Edward H. Weil, Mr. Thomas Hockley, Mr. Samuel Wagner, of Philadelphia; from Prof. Lyman B. Hall, Ph.D., Haverford College, Pa.; and Prof. John W. Moore, M.D., Lafayette College, Easton, Pa.

Letters of envoy were received from the Department of the Interior, and La Société Royale des Sciences d'Upsal.

Letters were read from the Bureau of Ethnology (Washington) asking for several copies of Proceedings No. 115; from the Societas pro Flora et Fauna Funica, asking for Proceedings Nos. 109, 110, 111, 112; from the Mercantile Library Company of Philadelphia, asking for certain volumes to complete its set of Transactions, all of which requests were granted.

The University of Michigan was ordered to be placed on the list of exchanges, and as full a set as possible of the Society's Proceedings and Transactions ordered to be made up and sent to its Library.

Letters were received from members subscribing to the Proceedings of the Society to be issued quarterly hereafter.

The death of Herman Kolbe, of Leipzig, was announced as having taken place on November 26, 1884, aged 66 years.

The President announced that he had appointed Dr. J. T. Rothrock, to prepare an obituary notice of the late Vice-President, Eli K. Price, and that the appointment had been accepted.

Prof. Dr. Hayes Agnew, M.D., read by appointment, an obituary notice of the late Rev. Elias R. Beadle.

Rev. E. W. Syle, made a communication on Education in China.

Prof. E. D. Cope, made a communication on the Systematic position of the Pterichtys in the Red Sandstone, illustrating his remarks with specimens.

Dr. D. G. Brinton presented a communication from Miss Abby L. Alger (of Boston), entitled "A Collection of Words and Phrases from the Passamaquoddy Tongue," *also* a communication from Dr. Otto Stoll (of Zürich), entitled "Supplementary Remarks to the Grammar of the Cakchiquel Language, edited by Dr. Brinton in the Proceedings of the American Philosophical Society."

Mr. Phillips presented a further note on the letter *Zed;* "Captain R. C. Temple, of Ambálá, Pánjâb, India, editor 'Pánjâb notes and queries' writes me: 'If *Zed* (as I think with Isaac Taylor) is really equivalent to tsadde, then it would bear the same value as the Arabic *sād* or *zād;* this if spoken of by Arabs specifically, would be El-zad, which by a well known euphonic law in Arabic would be pronounced as *ezzād;* perhaps the original of the word izzard.'

"Another correspondent has been good enough to call to my attention that in a paper read at the October meeting, 1876, of the Spelling Reform Association, Prof. Haldeman, speak-

ing of the letter *z*, says it represents the *third* sound in *wisdom*."

Pending nomination, No. 1049, was read.

The President reported that he had received and passed over to the Treasurer the quarterly interest of the Michaux legacy last due, amounting to $133.07.

The vacancy in the Committee on the Michaux legacy was filled by the election of Mr. Thomas Meehan.

On motion of Dr. Brinton, it was resolved that a fixed price of four dollars a volume should be charged for the Proceedings to non-members, and one dollar to members not paying annual subscription.

On motion of Dr. Brinton, a letter from G. P. Putnam's Sons, (New York City, N. Y.), in relation to a price list of the publications of learned societies was referred to the Secretaries with permission to act.

The rough minutes were read, and the Society was adjourned by the President.

Stated Meeting, February 20, 1885.

Present, 7 members.

Secretary, Dr. BRINTON, in the Chair.

Prof. Lyman B. Hall (of Haverford), a new member, was presented to the Chair and took his seat.

Donations for the Library were received from the Royal Society of New South Wales; the Bureau of Statistics at Stockholm; the Natural History Society at Bamberg; Dr. G. Vom Rath, of Bonn; the Geographical Society at Paris; the Annales des Mines; Mr. James Jackson; the Royal Astronomical Society; London Nature; the Journal of Forestry; Dr. Benjamin Ward Richardson; the Peabody Museum; the Essex

Institute; the Rhode Island Historical Society; the American Chemical Society; Mr. John B. Alden, and the Universal Library Company of New York; the Historical Society at Buffalo; the American Journal of Science; the Numismatic and Antiquarian Society of Philadelphia; the Hospital of the Protestant Episcopal Church; the Second Geological Survey of Pennsylvania; the United States Fish Commission; the War Department; Mr. Jed. Hotchkiss, of Staunton, Va.; Mr. Charles C. Jones, Jr., of Macon, Ga.; and the Academy of Natural Sciences in Cordoba.

The Treasurer reported that Mr. George B. Roberts had verbally accepted membership in the Society.

Letters were read from Mr. Fred. Gutekunst (712 Arch street, Philadelphia), and also from Dr. Albin Weisbach (Freiburg, Saxony), accepting membership in the Society.

Letters were read from Mr. Robert Treat Paine (Brookline, Mass., Feb. 12, 1885) relative to the Solar Eclipse of March 16, 1885, and enclosing a newspaper cutting in relation to the same; from Dr. Franklin B. Hough (Lowville, N. Y., February 9, 1885), suggesting that the Society should exchange with the "Société Nationale d'Agriculture de France" (Rue de Bellechase 18, Paris); from the American Journal of Archæology, soliciting subscription; to which on motion, the Society subscribed.

Letters of envoy were read from the Universal Library Company (of New York, N. Y.), Academy of Natural Sciences at Philadelphia, J. Simpson Africa, Secretary of Internal Affairs (Harrisburg, Pa.), R. I. Historical Society (Providence, R. I.), Essex Institute (Salem Mass).

Acknowledgments were read from the Franklin Institute ("Register of Papers" &c.), Essex Institute (110, 111, 112).

Mr. Phillips exhibited a writing box that he had lately found in the attics of the Society's Hall, of which he gave the following account:

May 15, 1785.

The Earl of Buchan presented "an authentic picture of Copernicus" on the lid of "a box of Yew," on the inside of which is a picture of

Napier, and "consecrated this curious piece of furniture to the Society, desiring, however, that Dr. Rittenhouse should have the use and custody of it during his life, producing it occasionally when he thinks proper."

1797, June 16, the box was returned by the widow of Dr. Rittenhouse, and has been in the custody of the Society ever since.

The proceedings of the Board of Officers and Council were submitted.

Pending nomination No. 1049 was read.

On motion of J. Sergeant Price, it was resolved that the Secretaries be instructed to omit and withdraw from the publications of this Society, any paper which having been presented to it for publication shall have appeared elsewhere in print before the number of the Society's publication in which it is to appear shall have been distributed.

The rough minutes were read, and the Society was adjourned by the presiding member.

Stated Meeting, March 6, 1885.

Present, 9 members.

President, Mr. Fraley, in the Chair.

Donations for the Library were received from the Senckenberg Naturalist Society; the Society of Natural Sciences at Wiesbaden; the Zoölogischer Anzeiger; the Royal Academy of Sciences of Belgium; the Royal Academy dei Lincei; the Geographical Society at Paris; the Revue Politique; the Naval Observatory of San Fernando; the Royal Academy of History at Madrid; the Royal Astronomical Society at London; the Meteorological Council; London Nature; the Boston Society of Natural History; the American Journal of Science, Prof. Charles F. Chandler, of New York; the Young Mens' Association of Buffalo; Prof. C. A. Young; the Engineers' Club; the Franklin Institute; the Mercantile Library; Dr. Persifor Frazer;

Mr. Henry Phillips, Jr.; Mr. C. Davis English; Dr. D. Jayne & Son; the United States National Museum; the United States Geological Survey; the Department of the Interior; the Johns Hopkins University; Rev. Stephen D. Peet, of Chicago; the State Historical Society at Iowa City, and the University of California.

Mr Edward H. Weil, a newly-elected member, was presented to the Chair and took his seat.

Acknowledgments for Proceedings 117 were received from Museum of Comparative Zoölogy, &c.; The Peabody Museum (Cambridge, Mass.); Connecticut Historical Society; New Hampshire Historical Society; Rhode Island Historical Society; New Jersey Historical Society; Cincinnati Observatory; United States Military Academy at West Point, N. Y.; Numismatic and Antiquarian Society of Philadelphia; Georgia Historical Society; Wisconsin Historical Society; United States Naval Institute at Annapolis, Md.; Essex Institute; Chicago Historical Society; University of the City of New York; American Antiquarian Society; Philosophical Society of West Chester; University of California; Public Library of New Bedford; United States Geological Survey (116, 117); Prof. J. W. Moore, Easton, Pa.; Henry Phillips, Jr., Philadelphia.

A letter was read from Mr. C. Stuart Patterson (dated Philadelphia, January 20, 1885), accepting membership in this Society.

Letter of envoy from the Meteorological Office (London, January, 1885) was read.

A letter was read from the Young Mens' Library, Buffalo, N. Y., accompanying an envoy of certain of its own publications and stating that it had not received any of the Society's Proceedings and Transactions since 1863. On motion it was ordered that they should be sent and that the Library should be continued on the list of the Society's exchanges.

The Scientific Library of the United States Patent Office requested all Transactions after Vol. XIII, which were ordered to be sent regularly as published.

The death of Mr. Samuel Powel was announced as having taken place at Newport, R. I., on March 5, 1885, in the sixty-seventh year of his age. On motion, the President was authorized at his discretion to appoint a member to prepare an obituary notice of the deceased.

The Committee on the Michaux Legacy was, on motion, reconstructed by the Society as follows: Thomas Meehan, Frederick Fraley, J. Sergeant Price, Aubrey H. Smith, and William M. Tilghman.

Nomination No. 1049 and new nominations Nos. 1050, 1051, 1052 and 1053 were read.

The rough minutes were read and the Society was adjourned by the President.

The Recent Danish Explorations in Greenland and their Significance as to Arctic Science in General. By H. Rink.

(Read before the American Philosophical Society, March 20, 1885.)

No country appears to be better qualified to throw light on the problems of polar geography in general than Greenland. Unto its southern point, though reaching the latitude of Southern Norway, it thoroughly maintains an arctic nature. Its northern extremity has not as yet been explored; here it disappears in regions which hitherto have braved the efforts of the boldest discoverers. This extent from south to north offers a peculiarly favorable opportunity for establishing meteorological stations and for observing how organic life on the terra firma gradually succumbs to the severity of the climate. Here also human inhabitants in their struggle for existence have advanced further towards the pole, the utmost limit of their abodes not being as yet pointed out with certainty. Moreover the mountains of the Greenland coast contain fossil remains important for illustrating the conditions of the Arctic regions during an earlier geological epoch. Its interior can be considered as not yet visited by travelers, but nevertheless we know about it that in its central regions those masses of snow accumulate which, converted into ice as floating icebergs, are spread over the north western Atlantic, stragglers even reaching the latitude of Spain. Upon the northern hemisphere Greenland is the only country that provides the ocean with these enormous fragments, and it is the unbroken continental character of its interior part which enables it to afford the

quantity of snow necessary for producing them. No wonder therefore that modern polar expeditions have considered the exploration of the northernmost part of Greenland one of their chief objects. An expedition has lately concluded which tried to advance in this direction; what these travelers have performed will certainly for ages not be surpassed. The frightful sufferings which they endured, their martyrdom in the service of science, give evidence of the desolate condition, the terrible climate of the coasts they have discovered. In this way the exploration of that part of Greenland can be considered as concluded for the present, and it might perhaps be of some interest to see what has been performed during the latest years with regard to physico-geographical investigation of what we might call Southern Greenland. The fact is, that since 1876 the Danish government has constituted a more *systematic survey of the Danish districts* conformably to a plan proposed by Professer of Mineralogy, P. Johnstrup, namely by sending small parties of travelers with the trading ships. While in Greenland they had to depend on the means of conveyance existing there. Besides surveying and drawing maps, their aims were chiefly geology and mineralogy, occasionally other branches of natural history, and archæology.

If we supposed that Greenland did not extend further towards the north than to the extreme point discovered by the Greeley expedition, its circumference according to a line drawn through the projecting points, omitting the indentations or inlets, might be calculated at 3600 miles, of which the Danish districts make 1000 miles. Of these the expeditions in question have surveyed 670 miles, or an area of 28,000 square miles of coast land including the branches of the sea intersecting it, the fjords and sounds. In Greenland these inlets represent the only highways; where they end, the vast glacier that covers the whole interior begins, and this has only exceptionally been ascended by travelers. Of course these journeys have not been exempt from the troubles and dangers connected with all sorts of Arctic traveling, and required both courage and perseverance, but on the other hand it is a matter of course, that the vicinity of our trading-stations on the coast offered the expeditions a support that enabled them to give more detailed information about the localities visited, than was possible in most cases to the polar expeditions in the far more desolate regions where they wintered or passed by.

The travelers who in different parties have performed these investigations to the summer of 1883 included, have been: Geologist K. J. V. Steenstrup (eight summers and two winters); Lieutenants of the Navy G. Holm (four summers), R. Hammer (three summers and one winter), and A. D. Jensen (three summers); Geologists A. Kornerup (three summers) and Sylow (two summers); Painter Groth (two summers); Supernumerary Officer Larsen; Lieutenant of the Navy Garde; Geologists Knutsen (Norwegian) and Petersen; Botanist Eberlin (all of whom one summer). The traveling parties of 1884 will be briefly mentioned at the close.

THE GREENLAND INLAND-ICE AND THE EUROPEAN GLACIAL EPOCH.—Geologists have for many years been puzzled with the fact that the lowlands extending to the south of the Baltic are strewn with stones which could have no other origin than from the rocks of Sweden and Norway. As from time to time more attention was drawn to these mysterious blocks, they were discovered in a south-western and south-eastern direction, a boundary line drawn from the Rhine in Holland, through Hamburg, Erfurth, Lublin and Kiem in the heart of Russia. At the same time another curious phenomenon was met with in connection with the erratic blocks. Where occasionally the ground was rocky and did not surpass a certain height above the sea, the surface appeared polished and marked by peculiar streaks in a direction pointing more or less towards the home of the erratics. This fact suggested the idea, that the transportation of the blocks could have been occasioned by ice, in a similar way as when glaciers are seen sliding down the mountain slopes, hollowing out the ground and carrying stones along with them which afterwards will be seen covering the ground when a part of the glacier is melted. It is a matter of course, that in adopting this hypothesis we have to suppose an arctic climate to have ruled over these tracts of Europe above alluded to. But even if this be granted, it is obvious that many objections still might be raised. Above all we have to take into consideration the area indicated by the erratic blocks, and to answer the question whether in the present period any ice formation exists that only approximatively corresponds to the magnitude of the glacier of the European glacial epoch. The extent of the surface it has covered is already mentioned ; as regards its thickness, the traces left by it on mountain heights have led to the assumption that the ground where now Berlin is situated has been covered with 1000, the low valleys in Norway with upwards of 3000 feet of ice. The said question, however, we are able to answer in the affirmative by referring to Greenland. The recent explorations have now shown, by direct survey, that the margin of what we already have mentioned as the inland ice forms an unbroken line from south to north without any thoroughfare whatever. This certainly only accounts for 1000 miles of the supposed circumference of Greenland, but there is sufficient reason to suppose that the remaining 2600 miles on an average are similar. According to this assumption the area of the inland-ice can be calculated at 360,000 square miles at the least, perhaps we may say 400,000 square miles. It must only be added that very likely mountain chains may be found in the interior rearing their tops above the general ice covering, and consequently these summits are included.

THE INLAND-ICE CORRESPONDING TO AN INUNDATION.—I mentioned that the traces which the glacial epoch has left are limited to a certain height above the sea. This naturally conveys the idea of an inundation, and also from this point of view the present great glacier of Greenland offers the most striking similarity to the supposed ice-formation of remote

ages. When looked over from heights of the outer land, and as far as we know from travelers who have wandered over it, only the marginal part shows irregularities; towards the interior the surface grows more and more level and passes into a plain very slightly rising in the same direction. Here and there, a few mountain tops are seen emerging from the uniform surface. These remains of the submerged land now look like islands in a frozen ocean; they are called by the natives: "Nunataks." Upon these Nunataks, if they have a sufficient extent, snow certainly may likewise accumulate so as to form glaciers. But these patches of snow and ice serve to show the difference between ordinary highland-glaciers and the ice crust that encompasses the foot of the same mountains. Finally to prevent misapprehensions I must add, that in instituting a comparison I have only tried to indicate a similarity, not to identify the surface of the glacier with that of a frozen sea. It must be remembered that in the former the fissures are of a wholly different nature. The following pages will show to what disappointments a traveler would be submitted who ascended the inland ice hoping to find an inundated country upon which the water was covered, like a lake, with solid ice.

Movement of the Inland-Ice.—We have now considered how the great glacier is able to represent the glacial epoch approximatively as regards its extent, and the nature of its surface But the most important question still remains, how can the transportation of the boulders be explained? An Alpine glacier which carries stones down into the valley, piling them up as moraines, does not account for the probability of the *transportation of similar masses from Norway to Germany*, even if a sheet of ice from 1000 to 2000 feet thick had covered the way they had to pass. Here again we take recourse to Greenland, asking whether the inland-ice is liable to movements that might correspond to the power required for carrying such boulders? To this question an affirmative answer can be given. Recent investigations show that the great glacier is in continual movement from the interior towards the sea, but that this action is concentrated to some particular points in an extraordinary degree. These points are the so-called *ice-fjords* from which the icebergs issue to the sea. The quantity of these fragments corresponds to the velocity with which the margin of the glacier is pushed on towards the sea. As regards the intermediate spaces between the ice-fjords, the movement is so slight, that the thawing action of the summer warmth balances it, and is able to keep the margin within certain limits.

Lieutenant Jensen's excursion over the inland-ice in 1878.—For this excursion a locality was decided upon, in which the outer margin of the glacier had been annually seen by travelers who occasionally passed by during the lapse of more than a hundred years without any conspicuous change of its appearance having been observed. That it was frequently noted was a natural consequence of its situation, as the

icewall here projects almost to the open sea, from which it is separated only by a narrow sandy and marshy plain. It therefore faces the sea in its full height and for a length of about 16 miles, and can be seen from ships at a remote distance. This desolate spot is situated N. 62½° N. lat., and is well known under the name of the "Iceblink." Here Lieutenant Jensen ascended the glacier, followed by Kornerup, Groth and a Greenlander. They had their luggage loaded on small sledges to be dragged by the travelers themselves. The locality was extraordinarily favorable for observing the movements of the ice on account of the unusual number of Nunataks which here are seen. They form a sort of bulwark or palisade against the ice stream from the interior, the direction and force of which are visible in the disturbances caused in the fragile mass by striking against these hindrances. But at the same time the road across it is rendered dangerous and troublesome in a degree hardly to be imagined by people who never tried to ascend a glacier.

On a large scale, says Jensen in his report, the surface of the ice was undulating, sometimes rising by terraces and not so level as it appears from a distance. Where the gradient increased, the unevenness was enlarged too, the clefts varying from a few feet to upwards of a hundred in breadth. the length was sometimes many hundred feet but generally they were shorter. In many places they were so frequent that the walls were narrower than the fissures. Steep hummocks of ice were still more toilsome, and the tortuosities of the road prohibited using the rope which for security the travelers had stretched from one to another. In places the sledges had to be carried along on the top of the steep and narrow ridges between the gulfs. As soon as a sledge happened to slip sideways, the one that dragged it had instantly to prostrate himself lest he should be drawn into the abyss. When a cleft could be passed, one of the party had to jump over first, while the other remained behind with the sledge, and then both united their efforts to a sudden pull and push. Sometimes the sledge would fall into the crevice and be squeezed between its narrow walls, or would proceed with too much speed and slip into the next fissure. In other places where the slope was less considerable, the fissures were regularly parallel, very long and broad, but with longer intervals. A glance into these gulfs offered the most splendid view of an azure-blue, passing into the darkness of the narrow deep, in many cases perhaps a thousand feet beneath the surface. Sometimes there were no depths at all, and then the water-courses for want of sufficient outlets formed small brooks or lakes very troublesome to the wanderers. The surface was studded with needles of ice, cutting the footgear as well as the hands.

When they had reached a height of 2000 feet above the sea a deep layer of snow commenced covering the ice. This caused more labor in dragging the sledges and greater danger by concealing the abysses.

On the seventh day snow-blindness began to make its appearance. Finally, on the eleventh day, the 24th of July, they reached their goal, the foot of the Nunatak, from the top of which an extensive view further

into the interior could be obtained. About forty miles in a straight line had been passed over, but what miles! No wonder that the explorers were brought to a state of utter exhaustion. As soon as they had arrived a strong gale arose, accompanied by a copious fall of snow and kept them imprisoned in their miserable hut for seven days. The provisions had not been calculated for such a sojourn ; the daily allowance therefore now had to be restricted to three quarters of a pound of food. Several times they tried to ascend the top of the hill, but in vain, on account of the terrible snowstorm, until finally on the eighth day they were released. When the weather cleared a grand and peculiar scenery lay unfolded to their sight. The mountain top was 5000 feet above the sea, while their tent at the foot of it was at a height of 4000 feet. To the east a snow-white plain was seen rising very gently and with no interruption whatever into the distant horizon. But to the south in their immediate vicinity several other Nunataks emerged, raising their summits boldly over the icy desert, and here *the true origin of the ice over which they had passed was at once plainly visible.* Though apparently resting it could not have been formed on the spot, but *was brought thither from the interior of the continent.* The Nunataks had been an obstacle to their movement, and the traces of the enormous power against which they had to oppose their walls were manifested in the disturbances they had caused. On the east side, facing the interior, the ice was broken and piled up several hundred feet against the rocks like the breakers of an ocean, while to the south, and north and between the Nunataks it poured down like frozen waterfalls to be embodied in and leveled with the crust over which the travelers had passed.

The rocky hill just spoken of was not wholly destitute of organic life. In the moist and sheltered fissures a pretty large number of plants had taken root, some of them with pretty flowers, such as *Cerastium, Campanula, Potentilla, Ranunculus,* and on the very top, *Papaver nudicaulis.* The travelers even gathered leaves of sorrel (*Oxyria digyna*) as a contribution to their scanty store of provisions. Of animals, a small bird and some spiders were seen, the latter proving the existence of other insects.

Maps have been prepared, illustrating the movements of the ice by indicating how the huge, solid and fragile mass assumes the character of a fluid substance. It is stopped by the Nunataks, but accelerates its course when pressed between them. According to the maps the whole surveyed area of the inland-ice in this place can be calculated at 450 square miles, of which about 120 were less than 2000 feet above the sea. Considering that the latter part as early as the 20th of July was bare of snow and exposed by melting, it will not appear impossible, that during the lapse of ages the heat of the sun has counterbalanced the supply of ice from the interior.

EXPLORATION OF THE ICE-FJORDS.—We have now to consider the more violent actions of the inland-ice caused by the concentration of its movements at certain points of the coast. Some have endeavored to classify

the ice-fjords according to their productiveness of icebergs or to the velocity with which the inland-ice is pushed into these inlets. We have five ice-fjords of the first, four of the second, and eight of the third (least productive) class. The Norwegian geologist Helland was the first who (in 1875) applied direct measurements to the actions of the ice here in question. Hammer and Steenstrup have completed these investigations as regards three first and one second rate fjords. They have proved that the branches of the inland-ice which the sea receives in these places are *pushed on incessantly at the rate of thirty to fifty feet per diem,* this movement being not at all influenced by the seasons. But the velocity thus found first acquires its whole significance by considering the quantity of matter to which it refers. The breadth of the glaciers which extend into the sea is of course variable, depending on the distance between the rocks which border them. In the large ice-fjords of Jakobshavn the glacier which yields the bergs was 4500 meters broad. The thickness can be estimated at a thousand feet. *The bulk of ice annually forced into the sea,* would, if taken on shore and resting on dry ground, make *a mountain two miles long, two miles broad and 1000 feet high.* Sliding over the bottom of the sea it maintains its coherent state until the water is sufficiently deep to lift it, when it breaks and is converted into floating bergs.

Lieutenant Hammer passed the winter from 1879 to 1880 at Jakobshavn for the purpose of surveying the fjord and watching the movements of the ice. He visited the station again in 1883 and has written an excellent monograph on this remarkable locality. By the striking results of his and Steenstrup's investigations, in connection with Helland's and still earlier observations as far back as 1851, we now have not only a trustworthy explanation of the origin of icebergs, but also of the removal of boulders hundreds of miles by the action of ice. A simple calculation will show that while large glaciers in other parts of the world are nourished by the snow falling upon a surface of perhaps twenty to thirty square miles, a first-rate ice-fjord will require a tributary basin upwards of a thousand times as large. For this reason the ice formed in the central regions of Greenland has to travel to the ice-fjords, and sliding over an uneven ground with its enormous weight it cannot avoid breaking asunder protruding rocks and carrying the fragments imbedded in its mass.

Can it be expected that Greenland once will be crossed from west to east or vice versa?—I am convinced that this will be accomplished. The problem seems not to present difficulties equal to such as have been encountered by expeditions in the northernmost parts of Greenland. If the chief object is to penetrate as far as possible into the interior, a starting point has to be selected where, if possible, no Nunataks could be observed from the outer land. Nordenskjöld has been the pioneer in this as well as other branches of arctic research. The renowned explorer has shown, on his voyages to Greenland in 1870 and 1883, how much can be performed by a carefully planned use of an Arctic summer. His excur-

sion over the inland-ice in 1870 disclosed regions of a nature never before observed, and in 1883 he passed far beyond the points reached by others. He took his starting point in 68° N. latitude. The first forty kilometers offered a very uneven ice, almost without snow and full of water-holes, ending in a height of about 1100 meters above the sea. For the next twenty two kilometers the ice was covered with a deep sheet of watery snow to a height of 1500 meters, and finally the Laplanders who followed him passed 115 kilometers, reaching a height of 2000 meters. The latter part of this road was quite level, but passing over deep snow without water, and only to be passed by means of snowshoes.

CONCLUSIONS WITH REGARD TO THE UNKNOWN REGIONS ABOUT THE POLES.—As far as I know, the existence of icebergs which might be supposed to have their origin from regions not yet discovered, about the North pole, has not been asserted. On the contrary, in the South sea, we not only meet with bergs whose origin must be derived from an unknown home, but whose dimensions by far exceed those of the arctic bergs. The latter may reach the height of between 300 and 400 feet above the level of the sea, but this only refers to edges or points occasionally turned upwards by the movements to which these floating bodies are concontinually liable. An iceberg tolerably preserved in its original state, with a flat surface, will not measure more than 100 feet on an average. According to the report given by the Challenger expedition the Southern bergs may be rated as nearly the double of this size. At the same time their perpendicular walls offer a structure marked by horizontal streaks which might augur a difference with regard to their formation. The report adds that these bergs undoubtedly are detached pieces of the large antarctic ice-covering, the perpendicular walls of which, measuring 180 feet in height, were seen by James Ross. Morover, it is inferred from the occurrence and nature of these blocks, that the South pole hardly can be supposed to be surrounded by continuous land of any extent, but most likely by smaller groups of islands. These tracts then, with exception of the high chain of volcanoes discovered by Ross, must be wholly buried under the same continuous sheet of ice. This description appears to suggest the idea, that the bergs originate more or less from the whole circumference of the ice-crust, which, according to the same supposition, must be imagined to be spread over more sea than land.

I can not conceive of such masses of ice having been accumulated without an extensive area contributing to it by concentrating the movements of its ice-covering to certain points of its circumference, and this again *requires a more or less continental character of the land* representing the said area. The chief part of the latter at least must consist of land. If the movement of the ice-covering was more equally distributed to the whole of its circumference, its margin in being pushed into the sea would be liable to break into smaller parts, and thus be gradually wasted before fragments like bergs could be formed and get afloat. At the same time

the absence of ice-bergs on the border of the unknown Arctic regions excludes the probability of any land of considerable extent being found there.

THE COAST REGIONS.—As regards the ordinary geographical survey of the regions bordering the sea, or intersected by its inlets, a few remarks may suffice concerning certain localities hitherto very little known.

In the first place we here have to mention the immediate *environs of the Cape Farewell.* This point was first explored by Lieutenant Holm, who in 1881 determined its situation by observations on the spot. He found it to be 59° 45′ N. lat. and 43° 53′ W. long. It constitutes a part of one of the lofty islands which here, separated by narrow sounds, gird the southern part of the mainland. The travelers were struck by its barren appearance even compared to Greenland. Many mountain heights of the southernmost mainland have been ascended; it may be supposed that further inland they reach a height of 10,000 feet. The inlets here, barren as they are, on the whole present picturesque scenery, on account of the contrast between the steep rocks with overhanging glaciers and the verdant spots at their foot.

We will now pass to *another part of the coast, situated between 67° and 68½° N. lat.* Although within the polar circle, the land nevertheless assumes a more pleasant appearance, presenting lower hills which, as a general rule, have no spots covered with perpetual snow and ice. Here the inland-ice recedes, and the space left by it is occupied by the most extensive tracts of lowland in Greenland. These regions have offered the *chief pasturing grounds for reindeer,* and during the summer season the natives from the south and the north formerly had here their rendezvous, pursuing their favorite sport, the reindeer chase. The fjords by which the country is intersected, afforded roads in various directions suitable to the *umiaks* or skin boats, and therefore this whole complex of land and inlets has always been well known to the natives. But they have rarely been visited by foreigners. For this reason Lieutenant Jensen, aided by Kornerup and Hammer, undertook the task of surveying them with the special aim of affording information about their eastern boundaries in front of the inland-ice.

The travelers were surprised at the number of reindeer horns, and of relics from the hunting-parties that lay scattered over an extensive space of ground, giving evidence of the sport that formerly had enlivened these lonely recesses, but of which very little is maintained. The reason of this decline is simply the disappearance of the animals, and their sudden decrease led to the belief in genial valleys in the interior of Greenland, to which the animals might have migrated. It may sound strange enough, but I believe that we can derive this hypothesis from some words of a document written 600 years ago, during the time of the old Norse colonies. I do not see in this disappearance of the reindeer anything else but an instance of the similar destruction of various kinds of game in almost every

other part of the globe. The chase gradually increased chiefly on account of the more common use of the rifle. It reached its culminating point in the years 1845 to 1849, when the number of deer killed might be rated at 25,000 annually. We may suppose that during those years one-half of the flesh was abandoned on the rocks, while a great many deers were killed only for the sake of the hide and the tongue.

Our travelers, in order to penetrate as far as possible towards the inland, followed an inlet that represented the most interesting type of a Greenland fjord. It is named Nagsutok (*i. e.*, rich in reindeer horns), measures in a somewhat curved line eighty miles in length and forms an almost regular channel two miles broad and from 1000 to 1500 feet deep. At the head of it no inland ice was met with, but a brook or river whose muddy water proved its origin from glacier ice. The country thereabout had a very attractive appearance. The slopes of the mountain sides and the lowland in front of them were clad in luxuriant green. A brook pouring down from the highland and winding through the plains was bordered by a thicket of willows measuring the height of a man, and showing stems of an arm's thickness. Having followed the river first by boat, and afterwards on foot about twenty miles, they were suddenly arrested by the inland-ice that reared its walls above the pleasant valley. The surface of the ice rose somewhat abruptly so as to surpass at a short distance the height of all the land in front of it. A considerable brook issued from the foot of the ice wall, bursting forth from the depth of a cave fifty feet high and broad, the sides of its interior being beautifully tinted with blue.

Finally *between the two northernmost stations, Umanak and Upernivik*, or from 71½ to 72½° N. lat. a peninsula projects, measuring about 1800 square miles. It presents the longest wholly uninhabited part of the coast-line, and was therefore like the former tract but imperfectly known. Two fjords running behind it from the south and from the north have been made use of by the natives as roads to meet from both sides during the hunting season. But during the present generation nobody was known to have passed the seaward coast of the peninsula in summer, either by kayak or by boat. However, in the month of February, when the sea is covered with solid ice, this way is passed with sledges, which regularly once a year, by conveying a mail, maintain a scanty intercourse between those remote settlements. Meeting now and then an ice bear is the only amusement which the postilions have to relieve the monotony of this wearisome passage. In 1879, Steenstrup, in order to survey the unknown tracts of the peninsula, resolved to try this road in summer time. The shore for many miles presented steep rocks without landing places and girt by numerous icebergs which frequently capsized and broke asunder threatening the passers-by with destruction. Furthermore, a dense fog often prevented their looking out for landing places. Notwithstanding these inconveniences Steenstrup found a party of natives willing to undertake the task, and he speaks in high terms about the carefulness, the courage and assiduity, with which they performed it even during a severe sickness that

happened to attack them. He succeeded in completing his circuit of the peninsula with its inlets, and in filling one of the principal blanks of our Greenland map.

THE ANCIENT GLACIAL EPOCH OF GREENLAND.—Largely provided as it is with ice-formations, Greenland, strange to say, has also a past ice period to boast of. The recent explorations have proved that what we have spoken of as the coastland free from ice was formerly covered with it like the inland, this ice covering reached, in the immediate vicinity of the present inland-ice, a height of 3000 to 4000 feet, and further to the seaward between 2000 and 3000 feet. All the usual traces of ancient ice-streams, the erratic blocks and the ground rocks, are the same here as in Northern Europe. These facts seem to corroborate the glacial theory as a whole. But I cannot agree with the supposition, that merely a change of climate, a rise of the annual mean temperature, should have caused the ice to recede in such a remarkable degree. The ice-fjords bear sufficient evidence of the large surplus of ice still produced by the interior. Should it happen that the bottom of the sea in front of them was raised so as to hinder the icebergs from going adrift and being dispersed, the fjords as well as the adjoining outshoots would soon again be leveled with the interior under the same icy covering. The ice-fjords, as we have seen, afford the drainage of the continent, but this at all events requires the existence of valleys or channels which are able to gather and conduct the downpour of snow and rain in a congealed state to the sea, in the same manner as in the ordinary way it is carried off by rivers. But the beds occupied by such ice-streams and concealed under the common surface of the inland-ice of course must be submitted to changes far more considerable than those of river beds. Consequently new outlets may be opened to conduct and discharge the excessive production of ice into the ocean, and this, I believe, in some measure may account for the ice crust having disappeared from tracts formerly buried under it.

ANCIENT VEGETATION OF GREENLAND.—Over an extensive tract of Greenland, mountains are found containing remains of plants which prove that the spot occupied by them in remote ages had *a climate like that of Southern Europe*, and some of them, like that of Madeira. In speaking of ages, we here refer to geological time, counted by many thousands of years, and changes since have taken place on a large scale as regards the configuration and distribution of land and sea, but it can be considered as a matter of fact that the area here in question has been occupied by tracts of land or perhaps groups of islands covered with the vegetation of a warm latitude. Its remains occuring in layers of sandstone and shale, accompanied by beds of coal, have attracted peculiar attention by the investigations of Professor Heer in Zürich, to whom the collections were sent in order to be determined. In 1866, Heer explained his reasons for concluding that the fossils laid before him belonged to plants that had grown on the very spot where the remains were found, or in its immediate vicinity

He alluded to one of these localities as bearing evidence of *a whole forest having been buried there.* Numbers of trunks and branches were imbedded in the sandstone formed out of the sand that once enveloped them. Reddish-brown ferruginous parts of the sandstone beds are filled with amazing quantities of leaves. Generally their substance is preserved, whereas some of them exist only as impressions. A piece of sandstone six inches square contained twenty-six leaves belonging to eleven species. In other pieces the leaves all belonged to the same species. As regards animals only the wing shells of some insects had been found. But fruits and seeds were found in connection with the leaves, all the parts being in such a state of preservation as to exclude the possibility of their having been carried from some distant place. They must have been derived from plants growing in a peaty soil and in the surrounding woods. The Arctic expeditions led to the discovery of similar remains in many places throughout the Polar regions from Banks land in the far west to Spitsbergen. But here again Greenland has offered the most favorable opportunities for exploration, and especially during the latest years afforded materials to throw light upon the other Polar regions with regard to this branch of natural science. The earlier series of discoveries were concluded by the rich collections brought home from Greenland by Nordenskjold in 1870, and completed by Nauckhoff in 1871. In the "*Flora fossilis arctica*" of Heer, the number of Greenland species was brought up to 316. By Steenstrup's collections in 1878–1880, this number was increased to 613; this result induced Heer to publish a separate work under the name of "*Flora fossilis Grenlandiea.*" Having received these latest collections from Greenland, Heer wrote that he would be able to describe the remarkable forests that during two geological epochs had covered those regions of the far north. He derives the fossil plants partly from *the tertiary,* partly from *the cretaceous period,* a long interval severing these divisions. The tertiary Flora of Greenland comprises not less than 200 species of trees and bushes. Tha woods presented twenty-eight coniferous, but far more foliferous trees, such as *poplars, birches, elm, plane-trees, ash, maple, beech, chestnut, a number of oak and walnut, four laurels, three ebony, six magnolias and two fan-palms.* The insects comprised thirteen species, but of Vertebrata not the least trace has been discovered.

Of the cretaceous plants the most important families are: Cycadeæ, Araucariæ, Zingiberaceæ, Balanophoræ and Sapotaceæ. *The Cycadeæ and the arboreous ferns* lead to the supposition of a climate like that of Funchal or Madeira, which during the tertiary epoch had passed into that of Southern France.

In 1883, Nordenskjöld was accompanied by the distinguished botanist, Nathurst, who, according to the preliminary report, has paid peculiar attention to the fossil Flora of Greenland, and not only discovered many new species, but also afforded valuable information as regards the number and chronological order of the strata and the question about the soil in which the plants have rooted.

Strata of Volcanic Origin, Native Iron.—Towards the close of the periods in which the remarkable remains of an ancient vegetation were accumulated, igneous matters must have burst forth from the interior of the earth and covered them to an amazing height and extent. As to their texture, their origin and mineralogical character they are undoubtedly to be classed with lava-streams, although in certain respects distinctly differing from them. These ancient lava-rocks, the trap and basalt, differ from those of present volcanoes by the absence of conical-shaped mountains that might indicate the channels through which the burning streams forced their way to the surface of the earth. In fact there are but few traces to be seen of their connection with the unknown depths whence they originated. We have before us extensive table-lands, between 2000 and 5000 feet high, with walls more or less perpendicular or terrace-shaped, and exhibiting a series of horizontal strata one above each other in a remarkably uniform manner. At the foot of these cliffs the sandstone in which the fossil plants are imbedded generally appear, forming slopes on lower hills, apparently the edges of a more extensive formation that lies concealed under the trap. But as regards the igneous rocks here in question, I shall only mention a discovery recently made concerning one of their most interesting features.

Native iron was found in Greenland thirty years ago, in the shape of a few loose pieces on the surface of the earth. In 1870 *enormous blocks were found by Nordenskӧjld*, the largest of them being estimated at 46,200 pounds, specimens of which the following year were brought to Europe by a Swedish expedition. Nordenskjöld observed that the basaltic rock in the immediate vicinity of these loose blocks of iron contained lamina of the same metal imbedded in its mass. The first pieces that had been found in Greenland, like native iron on the surface of the earth in other parts of the world, was determined as meteoric iron. The occurrence of iron in situ as a constituent part of the basaltic rock seemed to subvert this theory of a meteoric origin. Nordenskjöld, however, maintained it, stating that the downfall had taken place during the formation of the basalt. A long dispute arose about this question, which now must be considered as ended, *the meteoric origin almost universally having been abandoned* on account of a *discovery made by Steenstrup* during the last year of his stay in Greenland. It is also well known that John Ross, in 1818, found the Eskimo of Cape York in possession of knives in which they had inserted iron found by themselves in their country. Now Steenstrup, in 1879, on examining old Eskimo graves in the Umanak-fjord discovered in one of them knives just of the same description as those found by Ross, and with them in the same grave pieces of basalt were also discovered, which on being closely examined exhibited grains or nodules of iron like that inserted in the knives. It was the more obvious that the basalt pieces had been intended for such use, as in the same grave stone knives were found in connection with the raw materials of which they were made; quartz, chalcedony and such like. These facts suggested the idea that iron had been more com-

monly used by the Eskimo than could be expected if they had been restricted to pieces of meteoric origin. The next question was whether more localities could be pointed out where the basalt contained metallic iron. Just before leaving Greenland, in 1880, Steenstrup succeeded in solving this problem. On the west side of Disko island, at an abandoned wintering station called Asuk, he found a layer of basalt fifty feet thick filled with grains of iron of various sizes to a length of eighteen millimeters and a breadth of fourteen millimeters; which were the largest of them. Afterwards he found just the same sort of basalt on the west side of the island constituting much larger strata.

It may be added that in a conversation I had with the renowned Norwegian geologist Kjerulf about the questions here discussed, he referred to what has been long taught by him about the supposed increase of the specific gravity of minerals proportionately to the depth below the surface of the earth where they have their origin. He had instituted this comparison in order to find an explanation of the great difference between the earth's crust and its interior as to specific gravity. It has long been supposed from chemical proofs, that basalt contained metallic iron, but the occurrence of this substance in the shape of visible grains had never been ascertained before. For this reason Prof. Kjerulf considered the discovery of the huge iron blocks as still more important in certifying the origin of the iron from the depths of the earth and not from the atmosphere.

The present Flora of Greenland.—In 1857 the known species of of phanerogamous and of higher cryptogamous plants in Greenland amounted to 320. Several collections have since been secured. Prof. J. Lange undertook a revision of the whole material, by which the number of species was increased to 378. His results contradicted several earlier assertions. This flora is not (as suggested by J. D. Hooker), chiefly European; it is about *as much American as European*, chiefly American in the north, European in the south. For this reason the theory of its immigration from Europe can no longer be maintained. It is also incorrect to call this flora poor in comparison with other Arctic countries and to assert that no species exists peculiar to Greenland. Of course the area of the inland-ice has to be deducted with regard to this comparison. Not less than nineteen species are found that are peculiar to Greenland. But Greenland is relatively deficient in annual and biennial plants on account of the difficulty in having the seeds ripened. It should be remembered that the 10° C. isotherm of July passes from the middle of Labrador far south of Cape Farewell to Iceland.

Archæology.—Greenland in some measure can be called one of the elder colonies, if not one of the oldest. About the year 1000 it was peopled by Scandinavian settlers from Iceland. In 1450 their intercourse with Scandinavia was interrupted, when the country was re-discovered they

had disappeared, and an Eskimo population was met with instead. The present trading stations were founded after 1721. *Ruins of the ancient settlements*, however, were from time to time discovered, partly between 60° and 61°, and partly between 64° and 65° N. latitude, while the interjacent tract had been almost uninhabited. Our recent expeditions have not neglected the opportunity to continue these investigations, especially Lieutenant Holm has examined the remains in the southernmost of the two districts, According to his report 100 different ruins of ancient hamlets have been discovered there, the largest of them containing the remains of thirty buildings. The houses are from twelve to eighteen feet broad. The length is twenty to thirty feet or, when divided by a partition wall, fifty feet. Digging up the interior, burnt wood and iron nails are found on a level with the original floor, indicating a destruction by fire. Some very narrow buildings were evidently stables, the remains of stalls still being visible.

As barren highlands are frequent even in these most favorable portions of Greenland, the settlers were restricted to narrow borders of lowland, chiefly at the head of fjords. In contrast to Greenland scenery in general these spots exhibit a fertile and inviting appearance, especially where such a lowland continues across a peninsula joining a corresponding spot in the next fjord. The number of ruins show that these localities had the greatest attraction to the Scandinavians. Lieutenant Holm has given us a description of such a valley, the middle part of which had scarcely been visited by natives during the latest generations, and with perhaps a single exception, never by Europeans. From the head of the Igaliko-fjord, where the bishop of the ancient colony is supposed to have resided, a valley presenting low hills, plains and lakes runs across the peninsula that separates this fjord from that of Lichtenau (a Moravian station), a distance of eight to twelve miles. In the middle of this isthmus Holm discovered some ruins of considerable extent, but with walls only rising a few feet above the ground and overgrown by tufts of grass and willows. The environs of these stone-heaps, the only monuments that are able to tell about inhabitants whose final fate will forever remain a mystery, are described as very picturesque. Luxuriant copses of willows and low birch border the lakes, a magnificent waterfall is seen rushing over the rocky walls sprinkled with green, and in the background the mountains of the Lichtenau-fjord rear their tops into the air covered with perpetual snow and ice.

As regards *antiquities from the Eskimo period*, Steenstrup has examined a number of graves in the northern districts. Where natural masses of stones were found, the cavities formed by them had generally been preferred as sepulchral rooms, but when these were lacking, the dead used to be buried on the tops of the hills. In "Unknown Island" (latitude 71°) a cemetery was found at a height of 640 feet and only accessible by a steep and narrow path. The graves are built up with walls of stones, flat stones used as a roof. Generally they offer room enough only for the corpse in a bent position, but sometimes the dead are laid at full length. Often two

corpses or even more are in the same chamber. Such a room was once found measuring four feet in length by two feet in breadth, and containing the skulls of thirteen grown-up persons and two children. Several graves were found in which the number of skulls did not correspond to the rest of the skeletons. Still more curious were some graves carefully built but evidently never occupied by any dead. The properties which were considered as belonging to a person even after death were sometimes merely left at the side of the grave, sometimes lodged in separate rooms. In one instance a sepulchral chamber was found containing the weapons and tools of a kayak man, but no skeleton. Had these things perhaps drifted ashore, when their owners had found his resting place on the bottom of the ocean?

THE EAST COAST OF GREENLAND.—When compared with the districts we now have treated of, little attention has been paid to the coast east of Cape Farewell. Since 1828, to 1831, when Captain Graah explored the coast from its southernmost point to 65° latitude, this part of Greenland, still inhabited by heathen Eskimos, was not visited by exploring expeditions or by foreigners until 1883. We speak here only of the Danish part of the west coast, omitting the far north beyond 70° latitude. The difficulties arising from the drifting ice are very great, but still they do not account for a curious fact we here meet with. The coast from 65° to 70°, where Greenland approaches nearest to Europe and faces Iceland, has never been visited by foreigners. It is only 150 miles distant from Iceland, whose ancient settlers discovered Greenland, and still the inhabitants of this very part of Greenland have never seen people of other nations than their own. Another consideration has prompted a survey of the east coast. The ancient Norse colonies were divided into "Eastern" and "Western" settlements. When the first ruins of them were discovered, on account of their situation to the west of Cape Farewell, they were naturally supposed to be the remains only of the "Western settlement." Later it was supposed that both divisions were situated on the west side, one a little more to the east than the other.

In 1879, Captain Mourier, of the Danish navy, explored this unknown coast with the schooner *Ingolf* for a distance of about twenty-four miles. He stated that about the latitude of 65° the coast in many cases could be reached and a landing effected. Planning another expedition, it was suggested to proceed in two ways. A landing might be tried to the north of 70°, and then a voyage southward inside the ice barrier might be effected either by ship or by boat. The other way would be to follow the steps of Captain Graah by boat along the coast from Cape Farewell.

According to the latter plan, Lieutenant Holm, in 1883, again went to Greenland, followed by Garde, Knutsen and Eberlin. The first summer being intended only for preparatory arrangements, they departed from the southernmost settlement with four skin boats manned with natives and reached a place called Kassingertok in 61° latitude, where a hut was built

and filled with a depot of provisions for the next year, such as pemmican, meat biscuit, sugar, peas and barley. They then returned to their winter quarters at Nanortalik, on the west coast.

Meanwhile, Nordenskjöld had been engaged also with the east coast problem, and his efforts were crowned with a marvelous success. Having performed his excursion over the inland-ice and had his ship sent on an exploring voyage as far as Cape York, he reached the east coast about the latitude of 65½° and discovered a harbor where he anchored. Of course his stay could only be for a short duration, but still he is the first explorer who penetrated from the sea to this coast.

Expeditions of 1884.—In the spring of this year two expeditions set out for Greenland. The first consisted of Lieutenant Jensen with two scientific companions and was ordered to survey the district between 65° and 67° latitude. The other was led by Captain of the Navy C. O. E. Normann, an experienced traveler in Greenland, and an authority as regards Arctic questions in general. He commanded the man-of-war schooner *Tylla* ordered to inspect the fishing-banks in front of the trading districts and to continue the survey of the coast in connection with other explorations.

As regards the east coast explorers, a letter has arrived from the leader, dated the 17th of July, according to which they had reached the latitude of about 62°, having been as usual much impeded by ice. They hoped to reach a populous place called Angmagsalik, somewhat beyond 65° latitude, and to winter there.

On the Detection of Adulterations in Oils. By Prof. Oscar C. S. Carter, Central High School, Phila.

(Read before the American Philosophical Society, March 20, 1885.)

The chemical examination of oils is a very important though much neglected study. Important from the fact that the oils which command a high price in the market and are in general demand are frequently adulterated. The temptation to adulterate is great on account of the heavy increase in profit and because the adulterant is often very difficult of detection. The purchaser is always at the mercy of the oil merchant unless the oil be submitted to a chemical examination. "Our former Consul at Naples reported to the State Department that immense quantities of refined cotton seed oils are sent to Italy for the express purpose of sophisticating the

native olive oil, for the reason that it can be brought to Naples and sold at less than half the cost of producing pure olive oil." The cotton seed oil mixed with pure olive oil is exported to other countries. The price of fine salad oil is from three to four dollars per gallon, while cotton seed oil is worth from seventy to ninety cents per gallon. The oils commonly used to adulterate olive oil are colza oil, sesame oil and peanut oil. In the North of France poppy oil is used frequently because of its cheapness and neutral taste, and in Provence honey is used. In all probability glucose syrup has been tried. Linseed oil, the most important drying oil in the arts, so much used in varnishes and paints, is very often sophisticated. Even the seed from which the oil is made is mixed with other seeds. In India flaxseed is grown with mustard and rape. In Russia various proportions of hemp and linseed are sown together. Hemp seed yields an oil of an acrid odor, mild taste and yellow color, used in Russia for burning in lamps and making paints, varnishes and soap. The oils commonly mixed with linseed oil are niger, cotton seed, fish, rosin and coal oils. In this country lard is adulterated with palmnut and cocoanut oil, the latter is a white fat with the peculiar smell of the kernel. It was formerly made by grinding the kernel, boiling with water and subjecting the paste to a great pressure; a large quantity of milky juice is so obtained which is slowly boiled and the oil separates and is skimmed off. Twenty ordinary sized nuts yield about two quarts of oil. The strong taste of these oils is an objection, and may prevent their general use as adulterants and for the manufacture of oleomargarine. Lard oil which is obtained from lard is very valuable as a lubricant for machinery, and is also used for greasing wool in spinning. It is frequently adulterated with fish oils and cotton seed oils. Lard oil is worth one dollar and twenty cents per gallon, while cotton seed oil is worth about one-half as much.

The chemical analysis and detection of the adulterated oil is sometimes simple, but generally it is a difficult and trying task, especially when three or more oils have been mixed. The determination of the percentage of oil used to adulterate is out of the question and we must often be satisfied by simply proving that there has been a mixture without knowing the nature of it. But little work has been done on oils compared to the vast amount of research given to other subjects. Chemists have avoided the study and analysis of oils as difficult and uninteresting. We owe almost all we know to the labors of Chevreul and later to the researches of Prof. Allen and others. When oils are examined, chemical tests are the more important, but the physical tests are also very useful. At the present time we have not a characteristic test for each oil, as we have for each metal, that will distinguish it when mixed with other oils or that will identify it when alone.

When we examine an oil supposed to be adulterated, much can be accomplished by procuring a sample of perfectly pure oil and subjecting them both to the same tests and observing their behavior. A sample of lard oil supposed to be adulterated was received from a woolen manufac-

turer for examination. A specimen of perfectly pure lard oil was obtained and they were subjected to the same tests.

According to Professor Bechi, of Florence, the following test is reliable and delicate for detecting cotton seed oil in olive oil. The reagent is a one per cent solution of nitrate of silver in absolute alcohol. Place 5 c.c. of the suspected oil in a glass flask, add to it 25 c.c. of absolute alcohol and 5 c.c. of the test solution of nitrate of silver made as stated above. The flask is heated in a water bath at 84° C. (direct heat must not be used). If there be any cotton seed oil present, the mixture will begin to darken, the most minute quantity serving to discolor, and the tint assumed will depend upon the amount of cotton seed oil present. The test depends upon the fact that cotton seed oil will reduce nitrate of silver, but olive oil will not. This reduction is also caused by rape seed oil, but according to Bechi, pure olive oil will remain without discoloration under this test. While experimenting with the test I thought it might be of service in detecting cotton seed oil in lard oil; accordingly the sample of chemically pure lard oil was treated with absolute alchohol and nitrate of silver as directed and then heated; there was not the slightest discoloration of the pure lard oil; even on standing for two weeks it did not darken, thus proving it had no action upon the nitrate of silver. The lard oil obtained from the woolen manufacturer was then tested in the same manner; when it had been heated for a few minutes it began to darken and finally became quite black, thus proving that the lard oil was not pure but mixed with some other oil. I am not certain that the darkening is due to reduction; having made a series of experiments with salts of mercury, copper, and antimony and cotton seed oil to see if there would be any reduction I obtained no satisfactory results, and no reduction was noticed.

The elaidin test is sometimes very satisfactory, especially in detecting a mixture of a drying and non-drying oil and detecting adulteration of olive oil. This test depends upon the fact that olein and oleic acid in contact with peroxide of nitrogen yield a crystalline, solid, fatty body fusible at 32° C. to which Boudet has given the name elaidin. The nitrous vapors made by the action of nitric acid on copper are passed through the oil, or it may be shaken with a fresh solution of mercurous nitrate which has the property of retaining nitrous acid. Non-drying vegetable oils and most animal fats contain oleic acid. The following oils contain a high percentage of olein: olive, almond, rape, arachis (earth-nut), castor and the oils from lard and tallow. These oils form with nitrogen peroxide solid elaidin of a white or yellow color which in some cases is firm and resonant. The drying oils, such as linseed, hemp seed and poppy seed oils do not form solid elaidin with nitrous vapors but remain liquid for more than two days and become slightly colored. The elaidin test was applied to the adulterated lard oil and to the pure lard oil by adding an equal amount of nitric acid (Sp. Gr. 1.40), and some copper turnings. The elaidin produced by the pure oil was more firm and coher-

ent than that of the adulterated oil and was of a lighter color; also the nitrous fumes rose more rapidly through the pure oil. One curious fact noticed about the adulterated lard oil was, it could not be completely saponified with caustic soda; even when the latter was added in excess a clear layer of unsaponified oil remained after several trials. This test clearly indicated adulteration, as pure lard oil will completely saponify with caustic soda. Prof. Allen has proved that shark liver oil and African fish oil resist saponification. He tried to saponify the former oil with aqueous potash, with a solution of potash in absolute alchohol, and by heating it with solid potash, but it would not completely saponify, this he thinks is due to the fact that it contains a body allied to cholesterin, but fluid at ordinary temperatures.

Pure lard oil gives with nitric acid of Sp. Gr. 1.33 a yellow color approaching orange.

The adulterated sample of lard oil with nitric acid of the same strength gave a distinct brown color on standing. That portion of the oil which resisted saponification with caustic soda was treated with nitric acid, and it soon became of a deep coffee brown color, much darker than the above.

The determination of specific gravity is the most important of the physical tests. The viscosity of an oil is a highly important feature, but in order to be of any value in testing much care must be observed; both oils must be brought to the same temperature and kept so while flowing. Both the adulterated and the pure lard oil were subjected to this test, they were brought to a temperature of 80° F. and 5 c. c. of each oil was passed through a capillary tube. The pure oil required 960 seconds to pass through, while the adulterated oil required 1080 seconds. The experiment was repeated several times with different tubes, but the ratio of the times of flowing was constant. Both oils were subjected to a temperature of 32° F. When the pure oil was frozen it was more coherent and firm and much lighter in color; the adulterated sample was quite yellow. When the adulterated oil slowly became liquid a layer of yellow oil formed first, which was quite different in appearance from the other portion and was evidently the adulterant.

While we cannot depend on any single test, the evidence afforded by several is often conclusive and satisfactory, and in this case it was acknowledged afterwards that cotton seed oil was one of the adulterants.

THE ARUBA LANGUAGE AND THE PAPIAMENTO JARGON.

By Alb. S. Gatschet, Washington, D. C.

(*Read before the American Philosophical Society, July 18, 1884.*)

Aruba is the westernmost isle of the group of islands which extends from east to west along the northern coast of South America at a short distance from the mainland. It lies north of the peninsula of Para-

guana, Venezuela and north-east of the entrance to the Gulf of Maracaïbo; it belongs to the dominion of the Dutch in the West Indies, which extends over the following islands: Aruba (preferable to the orthography: Oruba), Curaçao, Curaçilla at the south-eastern cape of Curaçao, Bonaire or Buen Aire, and the two Aves or Bird islands. Curaçao is the largest island of the archipelago and consists of a barren rock almost devoid of vegetation; the capital of the Dutch colony, Wilhelmstadt, is built upon its south-western shore. In former times the thrifty inhabitants accumulated wealth as the mediators of a lively smuggling trade between the Spanish and other colonies of the West Indies. Salt is now the staple produce of Curaçao with its 22,000 inhabitants; as to its size, it is nearly three times larger than Aruba, which has 200 square kilometres and 5670 inhabitants.

The explorer Alphonse L. Pinart, from whom the linguistic material printed below was obtained, visited the Curaçao group in the summer of 1882. Although the natives of Aruba have since A. D. 1800 abandoned their paternal language for the Papiamento jargon, their exterior is still of a pure Indian type. The Aruban language was probably the same as that of Curaçao and related to the vernacular of the peninsula of Paraguana. From natives far advanced in age Pinart succeeded in obtaining a few terms of the Aruban language and of local nomenclature, also six sorcerer's formulas, and from the Papiamento, as spoken at present, he secured a limited number of plant and animal names evidently pertaining to the extinct Indian dialect; the number of these may be easily increased by future travelers.

An old Aruba Indian, recently deceased, witnessed at the former Indian encampment at Saboneta the inhumation of a native female in one of the large conical ollas, her body being doubled up within the vase and the head protruding through the orifice. A smaller urn was then placed upon the head, bottom up, and the whole covered with earth. Several Aruban grottoes and rock-shelters yielded inscriptions and pictographs to the explorer, who considers their style as related to the pictography of the Orinoco and Apure çountries. Fragments of pottery, hatchets made of shells and stones, are profusedly scattered around the ancient encampments of the native Arubans.

The name of *Curaçao* island seems to be the Tupi word coaracý, curassé *sun*, in Guarani quaraçí; *Aruba* resembles the name of a shrub which is called in French Guyana: arube. Nicolas Fort y Roldán, in his *Cuba indigena* (Madrid, 1881), p. 125, gives arabo as the name of a plant as heard once on the Great Antilles. For Curaçao compare: Navarrete, *Coleccion de los Viages*, III, pp. 259.

Nouns, verbs and sentences.

adamudu *rain*
bāru xantu uōu *to ask for something to eat*
ḍanshikkị, ḍanshēbụ *sack, pouch*

datiē ! *be gone!*
kāfa *devil, wicked spirit*
kaŋla (?kaula) *thing, object*
kantie baulēte ! *give me to eat!*
karebe *spoon*
χāba dōboχedan guayete ! *sit down!*
χida mēo ! *good morning!*
χomoi *phantom, hobgoblin*
χute kontābo ? *how do you do?*
totumba, waidānga *water-gourd.*

Names given to Aruban mountains and heights:

Aiyo, Behika, Cukūroi, Handebirari, Kasinari, Kibaima, Kodeko-dēktu, Matīvidiri, Shabururi, Shiribana, Tarabana, Wakubana, Ya-barubari, Yamanota.

Names of Aruban caves:

Matīvidiri, Warerūkuri, Waririkiri.

Names of Aruban places ("endroits") :

Antīkūri, Arikurari, Bedūi, Bushiribani (?), Cūbari, Damāri, Hen-dieku, Kamakūri, Kashiunti, Kausheati, Kassibari, Warirūri, Webūri, Yuditi.

Names of Aruban trees:

dabaraida ; hubădā tarabada.

Names of plants:

dividivi *fruit of Sapindus coriaria*
jobo *Spondias lutea*
kadushi *Cereus laniginosus*
kipopo *Agaricus*
lokiloki *Mimosa unguiscata*
makura *Abrus precatorius*
nandu *Cytisus catjan*
shimaruko *Malpighia glabra*
surun *Cratera gynandra*
takamahak *Ragara octandra*
tuturutu *Robinia pulcherrima*
watapana *Sapindus coriaria*
yoroyoro *Theretia neriflora.*

Names of fish:

ginga *Diodon atinga*
karmā-u *Characinus cyprinioides*
kurkur *Chætodon fromitus*
puruntsi *Serranus variolosus.*

Names of birds :

kinikini *Cymindes illigeri*
krabete *Fulica* — ?
shushubi *Orpheus americanus*
warawara *Cathartes curasoica.*

Insects and other animals :

dori *Rana* (— ?)
guruguru *Calandra granaria* (a beetle)
hanahana *Formica cephalota*
kimakima *Cassiopea frondosa* (a rhizopod)
kumexen *Termes fatalis*
lembelembe *Conops sanguisuga* (a dipteron)
mamondenga *Ichneumon niger*
paluli *Mytilus edulis*
waltaka *lizard.*

Several of these names are formed by duplication of the (dissyllabic) radix, a process occurring in many languages to indicate formation by onomatopoesy, or diminutive nouns, or objects existing in large numbers.

EXORCIST'S OR CONJURER'S FORMULAS.

Maledictory formula : χerebēte den kāfa magolotchi.
For frightening children : tue daye datiē′ gidio′ dimi guriō yatabo.
Two formulas to remove cactus-spines from the human body : (1) una areya rafayete dudrea ebanero abonō, caburo copudabo daburi.
(2) yuni roba rapebo tchaba na aripebo, duda banabo pebo, home daba burvo, damei bo bakuna, daodao fuda dada.
Formula to remove fish-bones or other obstructions from the throat : vidiē pahidiē, maranakō tubara tchira deburro, hadāra karara.
Formula for hunting the iguana : Sako den komanari manadi watapuna fāfa na douēre sadii na ditieri.

When A. L. Pinart gathered these formulas, he found it impossible to obtain any interpretation for the single words. When I remarked to him that such formulas of sorcery were often made up of unmeaning sounds and words, he scouted the idea, and said these sentences were literal quotations from the extinct Aruban tongue. It will be noticed that several words in them occur in the lists above : kāfa, datiē, watapuna (cf. watapana). In the formula preceding the last one, some rhythm resembling assonance is perceptible.

In making a study of the above lists, I have endeavored to classify the lost Aruba language among some of the circumjacent linguistic families. But the peculiar selection of the terms, which are very uncommon, the paucity and probable disfiguration of them in the mouth of the uneducated people have not permitted to find any other but passing analogies with the

above. Goajiro, which is spoken from the point of the Goajira peninsula down to the Gulf of Darien in various dialects, yielded the following :

Aruba : kāfa *devil*, Goaj. yarfâs, yaríâ, yaröjá.

All the other terms which I could compare with Goajiro, Guamaco, Arawak, Tupi and the extinct male and female Carib dialects of the Leeward islands (dialect of Guadeloupe, Dict. of Rev. Raym. Breton, 1665) differed entirely from Aruba. Hagē, the generic term for *ant* in the insular Carib, may be compared with hanahana, *Formica cephalota* of Aruban.

The Papiamento.

On account of the peculiar selection and association of their ingredients, and the grammatic changes which the terms are undergoing, the jargons or medley languages are now being studied by linguists with the interest they deserve. The best known jargons of America are the conversational Tupi or *lengoa geral*, the various negro jargons of Guyana, of the West Indies and of Louisiana, the Chinook jargon, etc. The main ingredient of Papiamento, which is spoken upon Aruba, Curaçao and the rest of this island group, is the Spanish language ; then comes Dutch, the language of the Netherlandish rulers, and least in frequency are the words of Indian origin.

The character of this medley speech will best appear from extracts taken from a "Conversational Guide," published at Curaçao, 1876.

Span. *comerciante :* comerchanti, *cajero* cajeru, *tenedor de libros* tenedó di buqui, *dependiente* clerc, *relojero* dreshadó di oloshi, *pastelero* trahadó di pastechi, *carnecero* matadó di bestia, *silletero* trajadó di stul, *ojelatero* blequero, *velero* seilemaker, *aserrador* zagdó di palu, *encuadernador* trajadó di buqui, *sastre* sneire (Germ. Schneider), *zapatero* zapaté, *albañil* meslá, *herrero* smet, *remendador* lapidó, *predicador* domí, *director de entierro* forlese, *sepulturero* coster, *consejo del templo* kerkerad, *púlpito* prekstul, *comunion* ricibimentu, *campanero* leidó di cloc.

The following objects of natural history are partly rendered by aboriginal Indian terms : Span. *arból de uva* palu di dreif, *arból de mamon* palu di quenepa, *arból de merey* palu di cachú ; *arból de guayaba* palu di guyaba, *pájaro* para, *yegua* meri, *mula* mula mujé, *burro* machu, *burra* buricu mujé, *mono* macacu, *rata* yacá, *pulga* pruga, *lombriz* bichi, *golondrina* souchi, *hormiga* bruminga, *cucaracha* cacalaca, *gavilan* guaraguara, *pollo* púitu, *pavo* calacuna, *papagayo* lora, *cienpie* disinbei (Dutch), *pauji* pajuis, *migajas* wiriwiri, *cante* conufes (a fish), *zavalo* snuc (a fish), *arenque en salza* pequelé (Dutch), *chimbobó* guiambó, *ahullama* pampuna, *lechoza* papaya, *aji* (or *chile*) promente [Span. pimiento], *cambur* bacoba, *guanábana* sorsaca, *plátano* banana, *chirimoña ó riñon* scopapel, *piña* anaza, *naraja* laraja, *ciruelas* preimu.

We add a few conversational sentences :

Debe ser tarde mesté 'a lat
No espera Usted al Sr. L.? bo no ta sperá shon L.?

Vé a ver otra vez si ha venido bai ueita atrové cu él á bini.
El Sr. L. está en casa? Shon L., ta na cas ?
Ha ido fuera ela vai afó
Hablas bien bo ta papia bon
Lo estimaré siempre lo mi stimabu tur mi vida
Quiere Usted jugar carta? mener quié jungá carta ? (mener : *mynheer*)
No tengo ganas de jugar mi non tin gustu dé jungá
Ha comido Usted bastante? bo a comé jopi ?
Es bastante léjos ta machá aleu
Estoy aun un poco débil ainda mi ta un poco suac
Cuantas iglesias hai aqui? cuantu misa tin aqui ?
Muchas en el campo jopi na cunucu.

The above examples plainly show that this jargon exhibits the same processes of linguistic deterioration as are commonly found in medley languages of this description.

Three dialects may be distinguished upon Curaçao island (Guide, p. 49) : that of the Dutch Protestants, marked by the peculiar accent of the Hollanders ; the one of the Jews, which comes nearer to the Spanish pronunciation ; the third dialect is that of the common people. The term papiamento signifies *talk, conversation* and is derived from *palabramentum*, palabra being the Spanish for *word, talk* (from παραβολή). The verb papiá means *to converse, speak.*

At Corsouw a weekly paper of four quarto pages was published from 1871 to 1875 in this jargon, which bore the title : *Civilisadó.* Courant di pueblo. Orden, trabouw, instruccion :—Progreso.

Judging from the titles below transmitted by the kindness of Mr. Pinart the literature of this isolated form of human speech has been up to the present time chiefly of a devotional character :

Guia para los Españoles hablar papiamento, y viceversa, para que los de Curazao puedan hablar español. Por N. N.—Curazao, imprenta del Comercio, 1876. 16°, 86 pages. (The title on the book-cover differs slightly from the inside title above.)

Jubileo di 1875. (Curazao) 1875. 16 p., 12°.
Historia corticoenan for di Bybel. 3ª edicion. Curaçao, Impr. del Vicariato, 1876. 24°. 4ª edicion, 1881.
Bida i sufrimentoe di nos Senjor Hesu Cristoe. Curaçao, Impr. del Comº, 1876. 59 pp., 16°.
Canticanan religiosa. 2ª edicion. Curazao, 1879. 24°.
Ciento cuenta corticoe. Boeke di leza pa uso di school. Curaçao, Impr. del Vicariato, 1881. 12°.
Boeki di leza pa uso di skool di dia domingo na Curaçao. Curaçao, 1881. 24°.
Catechismo i doctrina cristiana pa uso di Katholieken di Curaçao. Curaçao, Imprenta di Vicariato, 1882. 24°.

Rekenboek pa muchanan di Curaçao. Curazao, 1882. 24°.
Sagrado coerazon di Hesus ó meditaciounan pa luna di juni consagrar na S. coerazon i no bena na honor di es coerazon sagrado. N. L. and N. J. 206 pp., 32°.

A treatise on the Papiamento jargon was published by Emilio Teza in the *Politecnico* of Milan, Vol. xi, and also separately: *Il dialetto curassese*, Pisa, 1863. 8°.

Appendix.

(From manuscripts transmitted by Mr. Alph. L. Pinart.)

I. *Prayer to the Holy Virgin in the Karibisi dialect* (Karibisi tongo) *of Surinam.*

Odi Maria,

Jeretion Maria pololé genade tamoeni romo mālŏmā āmōro Kopo papōrijān Kopo papori walijan Santa Maria tamoeni sāno sēroĕpā toko wangonĭbō pōkō ērŏmē koman bōkŏ alamboe pŏmĕra. Kepobome.

II. *Lord's Prayer in the Cuna language,* as spoken on the Pacific slope of the Isthmus of Panamá. Reproduced in a *corrected* form from the *American Antiquarian,* Vol. v (1883), p. 354.

Patir nanguini, pechiqui niptalnega iiperekuichi ;
penukaguine petakeanguine pebiluleguine ;
pebalehas pepincheerguin, napkine pagaiopi niptalneguin ;
maatuda nanguin pan epanegun, emigoatguine ;
peanalchagogue animalguin, pel anniappigua ;
peanalchugo pel anayuppigua pelibanguimbi ;
pel imalistarguin ipeanaalchago, okuja Jesus.

patir *or* papa *father,* nanguini *our ;* maatuda *to-day,* pan *bread,* pe *thou,* igoat *give* (in emigoatguine), -guine plural suffix.

III. *Prayer to Christ in the Sambú dialect of Chocó, Columbian States.*

Naniuri biaunausi zese guanadi, mune-é mule Jesu Cristo zese umaquina etaupen zese redentor mune-é, maquiniamur umaquiniamur, zanaambul umandu caidebu tandé caidebu tandé caidé, zegabur careambur troadena, zaum beuatde, latiguai, cauai nambicansi convezainame cumli-i penitencia caima majorasnane convesai naninanei.

Pidele perdon a Dios, digas Señor mio Jesu Cristo, Dios y hombre, criador padre y redentor mio: pesame de todo corazon de haberte ofendido solo por ser quien eses tan digno de ser amado, y tambien me pesa porque me puedas castigar en el infierno, y propongo nunca mas pecar ayudado de tu divina gracia, confesarme y cumplir la penitencia que me mande el padre confesor.

The Philosophic Grammar of American Languages, as set forth by Wilhelm von Humboldt, with the translation of an unpublished memoir by him on the American Verb. By Daniel G. Brinton, M.D.

(Read before the American Philosophical Society, March 20, 1885.)

§ 1. Introductory.

The foundations of the Philosophy of Language were laid by Wilhelm von Humboldt (b. June 22, 1767, d. April 8, 1835). The principles he advocated have frequently been misunderstood, and some of them have been modified, or even controverted, by more extended research; but a careful survey of the tendencies of modern thought in this field will show that the philosophic scheme of the nature and growth of languages, which he set forth, is gradually reasserting its sway, after having been neglected and denied through the preponderance of the so-called naturalistic school during the last quarter of a century.

The time seems ripe, therefore, to bring the general principles of his philosophy to the knowledge of American scholars, especially as applied by himself to the analysis of American languages.

Any one at all acquainted with Humboldt's writings, and the literature to which they have given rise, will recognize that this is a serious task. I have felt it such, and have prepared myself for it not only by a careful perusal of his own published writings, but also by a comparison of the conflicting interpretations put upon them by Dr. Max Schasler,* Prof. H. Steinthal,† Prof. C. J. Adler,‡ and others, as well as by obtaining a copy of an entirely unpublished memoir by Humboldt on the "American

* *Die Elemente der Philosophischen Sprachwissenschaft Wilhelm von Humboldt's. In systematischer Entwicklung dargestellt und kritisch erläutert*, von Dr. Max Schasler, Berlin, 1847.

† *Die Sprachwissenschaft Wilhelm von Humboldt's und die Hegel'sche Philosophie*, von H. Steinthal, Dr., Berlin, 1848. The same eminent linguist treats especially of Humboldt's teachings in *Grammatik, Logik und Psychologie, ihre Principien und ihr Verhältniss zu einander*, pp. 123-135 (Berlin, 1855); in his well-known volume *Characteristik der Hauptsächlichsten Typen des Sprachbaues*, pp. 20-70 (Berlin, 860); in his recent oration *Ueber Wilhelm von Humboldt* (Berlin, 1883); and elsewhere.

‡ *Wilhelm von Humboldt's Linguistical Studies*. By C. J. Adler, A.M. (New York, 1866). This is the only attempt, so far as I know, to present Humboldt's philosophy of language to English readers. It is meritorious, but certainly in some passages Prof. Adler failed to catch Humboldt's meaning.

Verb," a translation of which accompanies this paper. But my chief reliance in solving the obscurities of Humboldt's presentation of his doctrines has been a close comparison of allied passages in his various essays, memoirs and letters. Of these I need scarcely say that I have attached the greatest weight to his latest and monumental work sometimes referred to as his "Introduction to the Kawi Language," but whose proper title is "On Differences in Linguistic Structure, and their Influence on the Mental Development of the Human Race."*

I would not have it understood that I am presenting a complete analysis of Humboldt's linguistic philosophy. This is far beyond the scope of the present paper. It aims to set forth merely enough of his general theories to explain his applications of them to the languages of the American race.

What I have to present can best be characterized as a series of notes on Humboldt's writings, indicating their bearing on the problems of American philology, introducing his theories to students of this branch, and serving as a preface to the hitherto unpublished essay by him on the American Verb, to which I have referred.

§ 2. Humboldt's Studies in American Languages.

The American languages occupied Humboldt's attention earnestly and for many years. He was first led to their study by his brother Alexander, who presented him with the large linguistic collection he had amassed during his travels in South and North America.

While Prussian Minister in Rome (1802–08), he ransacked the library of the *Collegio Romano* for rare or unpublished works on American tongues; he obtained from the ex-Jesuit Forneri all the information the latter could give about the Yurari, a tongue spoken on the Meta river, New Granada;† and he secured accurate copies of all the manuscript material on these

* *Ueber die Verschiedenheit des menschlichen Sprachbaues und ihren Einfluss auf die geistige Entwickelung des Menschengeschlechts.* Prof. Adler translates this: "The Structural Differences of Human Speech and their Influence on the Intellectual Development of the Human Race." The word *geistige*, however, includes emotional as well as intellectual things.

† *Ueber die Verschiedenheit*, etc., Bd. vi, s. 271, note. I may say, once for all, that my references, unless otherwise stated, are to the edition of Humboldt's *Gesammelte Werke*, edited by his brother, Berlin, 1841–1852.

idioms left by the diligent collector and linguist, the Abbé Hervas.

A few years later, in 1812, we find him writing to his friend Baron Alexander von Rennenkampff, then in St. Petersburg: "I have selected the American languages as the special subject of my investigations. They have the closest relationship of any with the tongues of north-eastern Asia; and I beg you therefore to obtain for me all the dictionaries and grammars of the latter which you can."*

It is probable from this extract that Humboldt was then studying these languages from that limited, ethnographic point of view, from which he wrote his essay on the Basque tongue, the announcement of which appeared, indeed, in that year, 1812, although the work itself was not issued until 1821.

Ten years more of study and reflection taught him a far loftier flight. He came to look upon each language as an organism, all its parts bearing harmonious relations to each other, and standing in a definite connection with the intellectual and emotional development of the nation speaking it. Each language again bears the relation to language in general that the species does to the genus, or the genus to the order, and by a comprehensive process of analysis he hoped to arrive at those fundamental laws of articulate speech which form the Philosophy of Language, and which, as they are also the laws of human thought, at a certain point coincide, he believed, with those of the Philosophy of History.

In the completion of this vast scheme, he continued to attach the utmost importance to the American languages. His illustrations were constantly drawn from them, and they were ever the subject of his earnest studies. He prized them as in certain respects the most valuable of all to the philosophic student of human speech.

Thus, in 1826, he announced before the Berlin Academy that he was preparing an exhaustive work on the "Organism of Language," for which he had selected the American languages exclusively, as best suited for this purpose. "The languages of a great continent," he writes, "peopled by numerous nationali-

* *Aus Wilhelm von Humboldt's letzten Lebensjahren. Eine Mittheilung bisher unbekannter Briefe.* Von Theodor Distel, p. 19 (Leipzig, 1883).

ties, probably never subject to foreign influence, offer for this branch of linguistic study specially favorable material. There are in America as many as thirty little known languages for which we have means of study, each of which is like a new natural species, besides many others whose data are less ample."*

In his memoir, read two years later, "On the Origin of Grammatical Forms, and their Influence on the Development of Ideas," he chose most of his examples from the idioms of the New World;† and the year following, he read the monograph on the Verb in American languages, which is printed for the first time with the present essay.

In a later paper, he announced his special study of this group as still in preparation. It was, however, never completed. His earnest desire to reach the fundamental laws of language led him first into a long series of investigations into the systems of recorded speech, phonetic hieroglyphics and alphabetic writing, on which he read memoirs of great acuteness.

In one of these he again mentions his studies of the American tongues, and takes occasion to vindicate them from the current charge of being of a low grade in the linguistic scale. "It is certainly unjust," he writes, "to call the American languages rude or savage, although their structure is widely different from those perfectly formed."‡

In 1828, there is a published letter from him making an appointment with the Abbé Thavenet, missionary to the Canadian Algonkins, then in Paris, "to enjoy the pleasure of conversing with him on his interesting studies of the Algonkin language."‖ And a private letter tells us that in 1831 he applied himself with new zeal to mastering the intricacies of Mexican grammar.§

About 1827, he found it indispensable to subject to a critical scrutiny the languages of the great island world of the Pacific

* From his memoir *Ueber das vergleichende Sprachstudium in Beziehung auf die verschiedenen Epochen der Sprachentwicklung*, Bd. iii, s. 249.

† He draws examples from the Carib, Lule, Tupi, Mbaya, Huasteca, Nahuatl, Tamanaca, Abipone, and Mixteca; *Ueber das Entstehen der grammatischen Formen, und ihren Einfluss auf die Ideenentwicklung*, Bd. iii, ss. 269-306.

‡ *Ueber die Buchstabenschrift und ihren Zusammenhang mit dem Sprachbau*' Bd. vi, s. 526.

‖ This letter is printed in the memoir of Prof. E. Teza, *Intorno agli Studi de Thavenet sulla Lingua Algonchina*, in the *Annali delle Università toscane*, Tomo xviii (Pisa, 1880).

§ Compare Prof. Adler's Essay, above mentioned, p. 11.

and Indian oceans. This resulted at last in his selecting the Kawi language, a learned idiom of the island of Java, Malayan in origin but with marked traces of Hindu influence, as the point of departure for his generalizations. His conclusions were set forth in the introductory essay above referred to.

The avowed purpose of this essay was to demonstrate the thesis that the *diversity of structure in languages is the necessary condition of the evolution of the human mind.**

In the establishment of this thesis he begins with a profound analysis of the nature of speech in general, and then proceeds to define the reciprocal influences which thought exerts upon it, it upon thought.

Portions of this work are extremely obscure even to those who are most familiar with his theories and style. This arises partly from the difficulty of the subject; partly because his anxiety to avoid dogmatic statements led him into vagueness of expression; and partly because in some cases he was uncertain of his ground. In spite of these blemishes, this essay remains the most suggestive work ever written on the philosophy of language.

§ 3. The Final Purpose of the Philosophy of Language.

Humboldt has been accused of being a metaphysician, and a scientific idealist.

It is true that he believed in an ideal perfection of language, to wit: that form of expression which would correspond throughout to the highest and clearest thinking. But it is evident from this simple statement that he did not expect to find it in any known or possible tongue. He distinctly says, that this ideal is too hypothetical to be used otherwise than as a stimulus to investigation; but as such it is indispensable to the linguist in the pursuit of his loftiest task—the estimate of the efforts of man to realize perfection of expression.†

* This is found expressed nowhere else so clearly as at the beginning of § 13, where the author writes: "Der Zweck dieser Einleitung, die Sprachen, in der Verschiedenartigkeit ihres Baues, als die nothwendige Grundlage der Fortbildung des menschlichen Geistes darzustellen, und den wechselseitigen Einfluss des Einen auf das Andre zu erörtern, hat mich genöthigt, in die Natur der Sprache überhaupt einzugehen." Bd. vi, s. 106.

† "Der Idee der Sprachvollendung Dasein in der Wirklichkeit zu gewinnen." *Ueber die Verschiedenheit*, ss. 10 and 11. The objection which may be urged that a true philosophy of language must deal in universals and not confine itself to mere differentiations (particulars) is neatly met by Dr. Schasler, *Die Elemente der Philosophischen Sprachwissenschaft*, etc., p. 21, note.

There is nothing teleological in his philosophy; he even declines to admit that either the historian or the linguist has a right to set up a theory of progress or evolution; the duty of both is confined to deriving the completed meaning from the facts before them.* He merely insists that as the object of language is the expression of thought, certain forms of language are better adapted to this than others. What these are, why they are so, and how they react on the minds of the nations speaking them, are the questions he undertakes to answer, and which constitute the subject-matter with which the philosophy of language has to do.

Humboldt taught that in its highest sense this philosophy of language is one with the philosophy of history. The science of language misses its purpose unless it seeks its chief end in explaining the intellectual growth of the race.†

Each separate tongue is "a thought-world in tones" established between the minds of those who speak it and the objective world without.‡ Each mirrors in itself the spirit of the nation to which it belongs. But it has also an earlier and independent origin; it is the product of the conceptions of antecedent generations, and thus exerts a formative and directive influence on the national mind, an influence, not slight, but more potent than that which the national mind exerts upon it.‖

So also every word has a double character, the one derived from its origin, the other from its history. The former is single, the latter is manifold.§

Were the gigantic task possible to gather from every language the full record of every word and the complete explanation of

* In his remarkable essay "On the Mission of the Historian," which Prof. Adler justly describes as "scarcely anything more than a preliminary to his linguistical researches," Humboldt writes: "Die Philosophie schreibt den Begebenheiten ein Ziel vor: dies Suchen nach Endursachen, man mag sie auch aus dem Wesen des Menschen und der Natur selbst ableiten wollen, stört und verfalscht alle freie Ansicht des eigenthümlichen Wirkens der Kräfte." *Ueber die Aufgabe des Geschichtschreibers*, Bd. i, s. 13.

† "Das Studium der verschiedenen Sprachen des Erdbodens verfehlt seine Bestimmung, wenn es nicht immer den Gang der geistigen Bildung im Auge behält, und darin seinen eigentlichen Zweck sucht." *Ueber den Zusammenhang der Schrift mit der Sprache*, Bd. vi, s. 428.

‡ "Eine Gedankenwelt an Töne geheftet." *Ueber die Buchstabenschrift und ihre Zusammenhang mit dem Sprachbau*, Bd. vi, s. 530.

‖ This cardinal point in Humboldt's philosophy is very clearly set forth in his essay, "*Ueber die Aufgabe des Geschichtschreibers*," Bd. i, s. 23, and elsewhere.

§ See *Ueber die Buchstabenschrift*, etc., Bd. vi, s. 530.

each grammatical peculiarity, we should have an infallible, the only infallible and exhaustive, picture of human progress.

§ 4. Historical, Comparative and Philosophic Grammar.

The Science of Grammar has three branches, which differ more in the methods they pursue than in the ends at which they aim. These are Historic, Comparative and Philosophic Grammar. Historic Grammar occupies itself with tracing the forms of a language back in time to their earlier expression, and exhibits their development through the archaic specimens of the tongue. Comparative Grammar extends this investigation by including in the survey the similar development of a number of dialects of the same stock or character, and explains the laws of speech, which account for the similarities and diversities observed.

Both of these, it will be observed, begin with the language and its forms, and are confined to these. Philosophic Grammar, on the other hand, proceeds from the universal constructive principles of language, from the abstract formulæ of grammatical relations, and investigates their application in various languages. It looks upon articulate speech as the more or less faithful expression of certain logical procedures, and analyzes tongues in order to exhibit the success, be it greater or less, which attends this effort. The grammatical principles with which it deals are universals, they exist in all minds, although it often happens that they are not portrayed with corresponding clearness in language.*

Philosophic Grammar, therefore, includes in its horizon all languages spoken by men; it essays to analyze their inmost nature with reference to the laws of thought; it weighs the relations they bear to the character and destiny of those who speak them; and it ascends to the psychological needs and impulses which first gave them existence.

It was grammar in this highest sense, it was the study of lan-

* "Les notions grammaticales resident bien plutôt dans l'esprit de celui qui parle que dans le matériel du language." Humboldt, *Lettre à M. Abel-Remusat Werke*, Bd. vii, s. 396. On the realms of the three varieties of grammar, see also Dr. M. Schasler, *Die Elemente der Philosophischen Sprachwissenschaft*, etc., s. 35, 36, and Friedrich Müller, *Grundriss der Sprachwissenschaft*, Band i, ss. 8-10 (Wien, 1876). Schasler observes that a main object in philosophic grammar is an investigation of "die genetisch-qualitativen Unterschiede der Redetheile," that is, of the fundamental psychological differences of the parts of speech, as, what is the ultimate distinction between noun and adjective, etc.?

guages for such lofty purposes as these, with which Humboldt occupied himself with untiring zeal for the last fifteen years of his life, when he had laid aside the cares of the elevated and responsible political positions which he had long filled with distinguished credit.

§ 5. Definition and Psychological Origin of Language.

Humboldt remarks that the first hundred pages or so of his celebrated "Introduction" are little more than an expansion of his definition of language. He gives this definition in its most condensed form as follows: "Language is the ever-recurring effort of the mind to make the articulate sound capable of expressing thought."*

According to this definition, language is not a dead thing, a completed product, but it is an ever-living, active function, an energy of the soul, which will perish only when intelligence itself, in its highest sense, is extinguished. As he expresses it, language is not an εργον, but an ενεργεια. It is the proof and the product of a mind *consciously* working to a definite end.

Hence, in Humboldt's theory the psychological element of *self-consciousness* lies at the root of all linguistic expression. No mere physical difference between the lower animals and man explains the latter's possession of articulate speech. His self-consciousness alone is that trait which has rendered such a possession possible.†

The idea of Self necessarily implies the idea of Other. A thought is never separate, never isolated, but ever in relation to another thought, suggested by one, leading on to another. Hence, Humboldt says: "The mind can only be conceived as in action, and *as action*."

As Prof. Adler, in his comments on Humboldt's philosophy,

* Steinthal does not like Humboldt's expression "to make capable" (fähig zu machen). He objects that the "capacity" to express thought is already in the articulate sounds. But what Humboldt wishes to convey is precisely that this capacity is only derived from the ceaseless, energizing effort of the intellect. Steinthal, *Die Sprachwissenschaft Wilhelm von Humboldt's*, s. 91, note. The words in the original are: "Die sich ewig wiederholende Arbeit des Geistes, den articulirten Laut zum Ausdruck des Gedanken fähig zu machen."

† "Nur die Stärke des Selbstbewusstseins nöthigt der korperlichen Natur die scharfe Theilung und feste Begrenzung der Laute ab, die wir Artikulation nennen." *Ueber das Vergleichende Sprachstudium in Beziehung auf die Verschiedenen Epochen der Sprachentwicklung*, Bd. iii, s. 244.

admirably observes: "Man does not possess any such thing as an absolutely isolated individuality; the 'I' and the 'thou' are the essential complements of each other, and would, in their last analysis, be found identical."*

On these two fundamental conceptions, those of Identity and Relation, or, as they may be expressed more correctly, those of Being and Action, Humboldt builds his doctrines concerning the primitive radicals of language and the fundamental categories of grammar.

§ 6. Primitive Roots and Grammatical Categories.

The roots of a language are classified by Humboldt as either *objective* or *subjective*, although he considers this far from an exhaustive scheme.†

The objective roots are usually descriptive, and indicate an origin from a process of mental analysis. They bear the impress of those two attributes which characterize every thought, Being and Action. Every complete objective word must express these two notions. Upon them are founded the fundamental grammatical categories of the Noun and the Verb; or to speak more accurately, they lead to the distinction of nominal and verbal themes.

The characteristic of the Noun is that it expresses Being; of the Verb that it expresses Action. This distinction is far from absolute in the word itself; in many languages, especially in Chinese and some American languages, there is in the word no discrimination between its verbal and nominal forms; but the verbal or nominal *value* of the word is clearly fixed by other means.‡

Another class of objective root-words are the adjective words, or Determinatives. They are a later accession to the list, and by their addition bring the three chief grammatical categories, the Noun, the Verb and the Adjective, into correlation with the three logical categories of Substance, Action and Quality.

* Ubi suprà, p. 17. Compare Humboldt's words, "Im Ich aber ist von selbst auch das Du gegeben." *Ueber die Verschiedenheit*, etc., Bd. vi, s. 115.

† *Ueber die Verschiedenheit*, etc., Bd. vi, s. 116; and compare Dr. Schasler's discussion of this subject (which is one of the best parts of his book), *Die Elemente der Phil. Sprachwissenschaft*, etc., ss. 202-14.

‡ Expressed in detail by Humboldt in his *Lettre à M. Abel-Remusat sur la nature des formes grammaticules*, etc., Bd. vii, ss. 300-303.

By the subjective roots, Humboldt meant the personal pronouns. To these he attributed great importance in the development of language, and especially of American languages. They carry with them the mark of sharp individuality, and express in its highest reality the notion of Being.

It is not easy to understand Humboldt's theory of the evolution of the personal pronouns. In his various essays he seems to offer conflicting statements. In one of his later papers, he argues that the origin of such subjective nominals is often, perhaps generally, locative. By comparing the personal pronouns with the adverbs of place in a series of languages, he showed that their demonstrative antedated their personal meaning.* With regard to their relative development, he says, in his celebrated "Introduction":

"The first person expresses the individuality of the speaker, who is in immediate contact with external nature, and must distinguish himself from it in his speech. But in the 'I' the 'Thou' is assumed; and from the antithesis thus formed is developed the third person."†

But in his "Notice of the Japanese Grammar of Father Oyanguren," published in 1826, he points out that infants begin by speaking of themselves in the third person, showing that this comes first in the order of knowledge. It is followed by the second person, which separates one object from others; but as it does so by putting it in conscious antithesis to the speaker, it finally develops the "I."‡

The latter is unquestionably the correct statement so far as the history of language is concerned and the progress of knowledge. I can know myself only through knowing others.

The explanation which reconciles these theories is that the one refers to the order of thought, or logical precedence, the other to the order of expression. Professor Ferrier, in his "Institutes of Metaphysics," has established with much acuteness the thesis that, "What is first in the order of nature is last in the order of knowledge," and this is an instance of that philosophical principle.

* *Ueber die Verwandtschaft der Ortsadverbia mit dem Pronomen in einigen Sprachen*, in the *Abhandlungen der hist.-phil. Classe der Berliner Akad. der Wiss.* 1829

† *Ueber die Verschiedenheit*, etc., Bd. vi, s. 115.

‡ *Gesammelte Werke*, Bd. vii, ss. 392-6.

§ 7. Formal and Material Elements of Language.

A fundamental distinction in philosophic grammar is that which divides the *formal* from the *material* element of speech. This division arises from the original double nature of each radical, as expressing both Being and Action.

On the one hand, Action involves Relation; it assumes an object and a subject, an agent, a direction of effort, a result of effort; usually also limitations of effort, time and space, and qualifications as to the manner of the effort. In other words, Action is capable of increase or decrease both in extension and intension.

On the other hand, Being is a conception of fixed conditions, and is capable of few or no modifications.

The *formal* elements of a language are those which express Action, or the relation of the ideas; they make up the affixes of conjugations and declensions, the inflections of words; they indicate the parts of speech, the so-called "grammatical categories," found in developed tongues. The *material* elements are the roots or stems expressing the naked ideas, the conceptions of existence apart from relation.

Using the terms in this sense, Humboldt presents the following terse formula, as his definition of Inflection: "*Inflection is the expression of the category in contrast to the definition of the idea.*"* Nothing could be more definitive and lucid than this concise phrase.

The inflectional or formal elements of language are usually derived from words expressing accessory ideas. Generally, they are worn down to single letters or a single syllable, and they usually may be traced back to auxiliary verbs and pronouns.

Often various accessories are found which are not required by the main proposition. This is a common fault in the narratives of ignorant men and in languages and dialects of a lower grade. It is seen in the multiplication of auxiliaries and qualifying particles observed in many American languages, where a vast

* His explanation of inflection is most fully given in his Introductory Essay, *Ueber die Verschiedenheit*, etc., § 14, *Gesammelte Werke*, s. 121, sqq. A sharp, but friendly criticism of this central point of his linguistic philosophy may be found in Steinthal, *Charakteristik der Hauptsächlichsten Typen des Sprachbones*, ss. 58-61. Humboldt certainly appears not only obscure in parts but contradictory.

number of needless accessories are brought into every sentence.

The nature of the relations expressed by inflections may be manifold, and it is one of the tasks of philosophic grammar to analyze and classify them with reference to the direction of mental action they imply.

It is evident that where these relations are varied and numerous, the language gains greatly in picturesqueness and force, and thus reacts with a more stimulating effect on the mind.

§ 8. The Development of Languages.

Humboldt believed that in this respect languages could be divided into three classes, each representing a stage in progressive development.

In the first and lowest stage all the elements are material and significant, and there are no true formal parts of speech.

Next above this is where the elements of relation lose their independent significance *where so used*, but retain it elsewhere. The words are not yet fixed in grammatical categories. There is no distinction between verbs and nouns except in use. The plural conveys the idea of many, but the singular not strictly that of unity.

Highest of all is that condition of language where every word is subject to grammatical law and shows by its form what category it comes under; and where the relational or formal elements convey no hint of anything but this relation. Here, only, does language attain to that specialization of parts where each element subserves its own purpose and no other, and here only does it correspond with clear and connected thinking.

These expressions, however, must not be understood in a genetic sense, as if historically one linguistic class had preceded the other, and led up to it. Humboldt entertained no such view. He distinctly repudiated it. He did not believe in the evolution of languages. The differences of these classes are far more radical than that of sounds and signs; they reach down to the fundamental notions of things. His teaching was that a language without a passive voice, or without a grammatical gender can never acquire one, and consequently it can never perfectly express the conceptions corresponding to these features.*

* See these teachings clearly set forth in his Essay, *Ueber das vergleichende Sprachstudium in Beziehung auf die verschiedenen Epochen der Sprachentwicklung*, *Werke*, Bd. iii, especially, s. 255 and s. 262.

In defining and appraising these inherent and inalienable qualities of languages lies the highest end and aim of linguistic science. This is its true philosophic character, its mission which lifts it above the mere collecting of words and formulating of rules.

If the higher languages did not develop from the lower, how did they arise? Humboldt answered this question fairly, so far as he was concerned. He said, he did not know. Individuals vary exceedingly in their talent for language, and so do nations. He was willing to call it an innate creative genius which endowed our Aryan forefathers with a richly inflected speech; but it was so contrary to the results of his prolonged and profound study of languages to believe, for instance, that a tongue like the Sanscrit could ever be developed from one like the Chinese, that he frankly said that he would rather accept at once the doctrine of those who attribute the different idioms of men to an immediate revelation from God.*

He fully recognized, however, a progress, an organic growth, in human speech, and he expressly names this as a special branch of linguistic investigation.† He lays down that this growth may be from two sources, one the cultivation of a tongue within the nation by enriching its vocabulary, separating and classifying its elements, fixing its expressions, and thus adapting it to wider uses; the second, by forcible amalgamation with another tongue.

The latter exerts always a more profound and often a more beneficial influence. The organism of both tongues may be destroyed, but the dissolvent force is also an organic and vital one, and from the ruins of both constructs a speech of grander plans and with wider views. "The seemingly aimless and confused interminglings of primitive tribes sowed the seed for the flowers of speech and song which flourished in centuries long posterior."

The immediate causes of the improvement of a language through forcible admixture with another, are: that it is obliged to drop all unneccessary accessory elements in a proposition; that the relations of ideas must be expressed by conventional and not significant syllables; and that the limitations of thought imposed

* The eloquent and extraordinary passage in which these opinions are expressed is in his *Lettre à M. Abel-Remusat*, *Gesammelte Werke*, Bd. vii, ss. 336–7.

† *Gesammelte Werke*, Bd. iii, ss. 218, 257.

by the genius of the language are violently broken down, and the mind is thus given wider play for its faculties.

Such influences, however, do not act in accordance with fixed laws of growth. There are no such laws, which are of universal application. The development of the Mongolian or Aryan tongues is not at all that of the American. The goal is one and the same, but the paths to it are infinite. For this reason each group or class of languages must be studied by itself, and its own peculiar developmental laws be ascertained by searching its history.*

With reference to the growth of American languages, it was Humboldt's view that they manifest the utmost refractoriness both to external influence and to internal modifications. They reveal a marvellous tenacity of traditional words and forms, not only in dialects, but even in particular classes of the community, men having different expressions from women, the old from the young, the higher from the lower classes. These are maintained with scrupulous exactitude through generations, and except by the introduction of words, three centuries of daily commingling with the white race, have not at all altered the grammar and scarcely the phonetics of many of their languages.

Nor is this referable to the contrast between an Aryan and an American language. The same immiscibility is shown between themselves. "Even where many radically different languages are located closely together, as in Mexico, I have not found a single example where one exercised a constructive or formative influence on the other. But it is by the encounter of great and contrasted differences that languages gain strength, riches, and completeness. Only thus are the perceptive powers, the imagination and the feelings impelled to enrich and extend the means of expression, which, if left to the labors of the understanding alone, are liable to be but meagre and arid."†

§ 9. Internal Form of Languages.

Besides the grammatical form of a language, Humboldt recognized another which he called its *internal form*. This is that

* This reasoning is developed in the essay, *Ueber das Vergleichende Sprachstudium*, etc., *Gesammelte Werke*, Bd. iii, ss. 241-268; and see ibid, s. 270.

† See the essay *Ueber die Buchstabenschrift und ihren Zusammenhang mit dem Sprachbau*, *Ges. Werke*, Bd. vi, ss. 551-2.

subtle something not expressed in words, which even more than the formal parts of speech, reveals the linguistic genius of a nation. It may be defined as the impression which the language bears of the clearness of the conceptions of those speaking it, and of their native gift of speech. He illustrates it by instancing the absence of a developed mode in Sanscrit, and maintains that in the creators of that tongue the conception of modality was never truly felt and distinguished from tense. In this respect its inner form was greatly inferior to the Greek, in the mind of which nation the ideally perfect construction of the verb unfolded itself with far more clearness.

The study of this inner form of a language belongs to the highest realm of linguistic investigation, and is that which throws the most light on the national character and capacities.*

§ 10. Criteria of Rank in Languages.

Humboldt's one criterion of a language was its tendency to *quicken and stimulate mental action.* He maintained that this is secured just in proportion as the grammatical structure favors clear definition of the individual idea apart from its relations, in other words, as it separates the material from the inflectional elements of speech. Clear thinking, he argued, means progressive thinking. Therefore he assigned a lower position both to those tongues which inseparably connect the idea with its relations, as the American languages, and to those which, like the Chinese and in a less degree the modern English, have scarcely any formal elements at all, but depend upon the position of words (placement) to signify their relations.

But he greatly modified this unfavorable judgment by several extenuating considerations.

Thus he warns us that it is of importance to recognize fully "that grammatical principles dwell rather in the mind of the speaker than in the material and mechanism of his language." †

This led him to establish a distinction between *explicit* grammar, where the relations are fully expressed in speech, and *im-*

* On this subtle point, which has been by no means the least difficult to his commentators, see Humboldt's Introduction *Ueber die Verschiedenheit*, etc., *Ges. Werke*, Bd. vi, ss. 45–6, 92–5, 254–5, by a careful comparison of which passages his real intent will become apparent.

† *Lettre à M. Abel-Remusat, Ges. Werke*, Bd. vii, s. 396.

plicit grammar, where they are wholly or in part left to be understood by the mind.

He expressly and repeatedly states that an intelligent thinker, trained in the grammatical distinctions of a higher language, can express any thought he has in the grammar of any other tongue which he masters, no matter how rude it is. This adaptability lies in the nature of speech in general. A language is an instrument, the use of which depends entirely on the skill of him who handles it. It is doubtful whether such imported forms and thoughts appeal in any direct sense to those who are native to the tongue. But the fact remains that the forms of the most barbarous languages are such that they may be developed to admit the expression of any kind of idea.

But the meaning of this must not be misconstrued. If languages were merely dead instruments which we use to work with, then one would be as good as another to him who had learned it. But this is not the case. Speech is a living, physiological function, and, like any other function, is most invigorating and vitalizing when it works in the utmost harmony with the other functions. Its special relationship is to that brain-action which we call thinking; and entire harmony between the two is only present when the form, structure and sounds of speech correspond accurately to the logical procedure of thought. This he considered "an undeniable fact."

The measure of the excellence of a language, therefore, is the clearness, definiteness and energy of the ideas which it awakes in the nation. Does it inspire and incite their mind? Has it positive and clear tones, and do these define sharply the ideas they represent, without needless accessories? Does its structure present the leading elements of the proposition in their simplicity, and permit the secondary elements to be grouped around them in subordinate positions, with a correct sense of linguistic perspective? The answers to these queries decide its position in the hierarchy of tongues.*

* "Nicht was in einer Sprache ausgedrückt zu werden vermag, sondern das, wozu sie aus eigner, innerer Kraft anfeuert und begeistert, entscheidet über ihre Vorzüge oder Mängel." *Ueber das Entstehen der Grammatischen Formen*, etc, *Werke*, Bd. iii, s. 272. Compare with this the expression in his celebrated *Einleitung:* "Die Sprache ist das bildende Organ des Gedanken," *Werke*, Bd. vi, s. 51. A perfected language will "allseitig und harmonisch durch sich selbst auf den Geist einwirken." Ibid, s. 311,

As its capacity for expression is no criterion of a language, still less is the abundance or regularity of its forms. For this very multiplicity, this excessive superfluity, is a burden and a drawback, and obscures the integration of the thought by attaching to it a quantity of needless qualifications. Thus, in the language of the Abipones, the pronoun is different as the person spoken of is conceived as present, absent, sitting, walking, lying, or running, all quite unnecessary specifications.*

In some languages much appears as form which, on close scrutiny, is nothing of the kind.

This misunderstanding has reigned almost universally in the treatment of American tongues. The grammars which have been written upon them proceed generally on the principles of Latin, and apply a series of grammatical names to the forms explained, entirely inappropriate to them and misleading. Our first duty in taking up such a grammar as, for instance, that of an American language, is to dismiss the whole of the arrangement of the "parts of speech," and, by an analysis of words and phrases, to ascertain by what arrangement of elements they express logical, significant relations.†

For example, in the Carib tongue, the grammars give *aveiridaco* as the second person singular, subjunctive imperfect, "if thou wert." Analyze this, and we discover that *a* is the possessive pronoun "thy;" *veiri* is "to be" or "being" (in a place); and *daco* is a particle of definite time. Hence, the literal rendering is "on the day of thy being." The so-called imperfect subjunctive turns out to be a verbal noun with a preposition. In many American languages the hypothetical supposition expressed in the Latin subjunctive is indicated by the same circumlocution.

Again, the infinitive, in its classical sense, is unknown in most, probably in all, American languages. In the Tupi of Brazil and frequently elsewhere it is simply a noun; *caru* is both "to eat"

* *Ueber das Entstehen der grammatischen Formen*," etc., *Werke*, Bd. iii, s. 292.

† Speaking of such "imperfect" languages, he gives the following wise suggestion for their study: "Ihr einfaches Geheimniss, welches den Weg anzeigt, auf welchem man sie, mit gänzlicher Vergessenheit unserer Grammatik, immer zuerst zu enträthseln versuchen muss, ist, das in sich Bedeutende unmittelbar an einander zu reihen" *Ueber das Vergleichende Sprachstudium*, etc., *Werke*, Bd. iii, s. 255; and for a practical illustration of his method, see the essay, *Ueber das Entstehen der grammatischen Formen*, etc., Bd. iii, s. 274.

and "food;" *che caru ai-pota*, "I wish to eat," literally "my food I wish."

In the Mexican, the infinitive is incorporated in the verb as an accusative, and the verb is put in the future of the person spoken of.

Many writers continue to maintain that a criterion of rank of a language is its lexicographical richness—the number of words it possesses. Even very recently, Prof. Max Müller has applied such a test to American languages, and, finding that one of the Fuegian dialects is reported to have nearly thirty thousand words, he maintains that this is a proof that these savages are a degenerate remnant of some much more highly developed ancestry. Founding his opinion largely on similar facts, Alexander von Humboldt applied the expression to the American nations that they are "des débris échappés à un naufrage commun."

Such, however, was not the opinion of his brother Wilhelm He sounded the depths of linguistic philosophy far more deeply than to accept mere abundance of words as proof of richness in a language. Many savage languages have twenty words signifying to eat particular things, but no word meaning "to eat" in general; the Eskimo language has different words for fishing for each kind of fish, but no word "to fish," in a general sense. Such apparent richness is, in fact, actual poverty.

Humboldt taught that the quality, not merely the quantity, of words was the decisive measure of verbal wealth. Such quality depends on the relations of concrete words, on the one hand, to the primitive objective perceptions at their root, and, on the other, to the abstract general ideas of which they are particular representatives; and besides this, on the relations which the spoken word, the articulate sound, bears to the philosophic laws of the formation of language in general.*

In his letter to Abel-Remusat he discusses the theory that the American languages point to a once higher condition of civilization, and are the corrupted idioms of deteriorated races. He denies that there is linguistic evidence of any such theory. These

* His teachings on this point, of which I give the barest outline, are developed in sections 12 and 13 of his Introduction, *Ueber die Verschiedenheit*, etc Steinthal's critical remarks on these sections (in his *Charakteristik der haupt. Typen des Sprachbaues*) seem to me unsatisfactory, and he even does not appear to grasp the chain of Humboldt's reasoning.

languages, he says, possess a remarkable regularity of structure, and very few anomalies. Their grammar does not present any visible traces of corrupting intermixtures.*

In a later work he returns to the subject when speaking of the Lenape (Algonkin Delaware) dialect, and asks whether the rich imaginative power, of which it bears the evident impress, does not point to some youthful, supple and vigorous era in the life of language in general? † But he leaves the question unanswered.

§ 11. Classification of Languages.

The lower unit of language is the Word; the higher is the Sentence. The plans on which languages combine words into sentences are a basic character of their structure, and divide them into classes as distinct and as decisive of their future, as those of vertebrate and invertebrate animals in natural history.

These plans are four in number:

1. By Isolation.

The words are placed in juxtaposition, without change. Their relations are expressed by their location only (placement). The typical example of this is the Chinese.

2. By Agglutination.

The sentence is formed by suffixing to the word expressive of the main idea a number of others, more or less altered, expressing the relations. Examples of this are the Eskimo of North America, and the Northern Asiatic dialects.

3. By Incorporation.

The leading word of the sentence is divided and the accessory words, either included in it or attached to it with abbreviated forms, so that the whole sentence assumes the form and sound of one word.

4. By Inflection.

Each word of the sentence indicates by its own form the character and relation to the main proposition of the idea it represents. Sanscrit, Greek and Latin are familiar examples of inflected tongues.

* *Lettre à M. Abel-Remusat. Werke*, Bd. vii, ss. 353–4.

† *Ueber die Verschiedenheit*, etc., Sec. 23, *Werke*, Bd. vi, s. 329.

It is possible to suppose that all four of these forms were developed from some primitive condition of utterance unknown to us, just as naturalists believe that all organic species were developed out of a homogeneous protoplasmic mass; but it is as hard to see how any one of them in its present form could pass over into another, as to understand how a radiate could change into a mollusk.

§ 12. NATURE OF INCORPORATION.

Of the four plans mentioned, Incorporation is that characteristic of, though not confined to, American tongues.

It may appear in a higher or a lower grade, but its intention is everywhere the effort to convey in one word the whole proposition. The Verb, as that part of speech which especially conveys the synthetic action of the mental operation, is that which is selected as the stem of this word-sentence; all the other parts are subordinate accessories, devoid of syntactic value.

The higher grade of incorporation includes both subject, object and verb in one word, and if for any reason the object is not included, the scheme of the sentence is still maintained in the verb, and the object is placed outside, as in apposition, without case ending, and under a form different from its original and simple one.

This will readily be understood from the following examples from the Mexican language.

The sentence *ni-naca-qua*, is one word and means "I, flesh, eat." If it is desired to express the object independently, the expression becomes *ni-c-qua-in-nacatl*, "I it eat, the flesh." The termination *tl* does not belong to the root of the noun, but is added to show that it is in an external, and, as it were, unnatural position. Both the direct and remote object can thus be incorporated, and if they are not, but separately appended, the scheme of the sentence is still preserved; as *ni-te-tla-maca*, literally, "I, something, to somebody, give." How closely these accessories are incorporated is illustrated by the fact that the tense augments are not added to the stem, but to the whole word; *o-ni-c-te-maca-e*, "I have given it to somebody;" when the *o* is the prefix of the perfect.

In these languages, every element in the sentence, which is not incorporated in the verb, has, in fact, no syntax at all. The

verbal exhausts all the formal portion of the language. The relations of the other words are intimated by their position. Thus *ni-tlaçotlaz-nequia*, I wished to love, is literally "I, I shall love, I wished." *Tlaçotlaz*, is the first person singular of the future, *ni-nequia*, I wished, which is divided, and the future form inserted. The same expression may stand thus: *ni-c-nequia-tlaçotlaz*, where the *c* is an intercalated relative pronoun, and the literal rendering is, "I it wished, I shall love."

In the Lule language the construction with an infinitive is simply that the two verbs follow each other in the same person, as *caic tucuec*, "I am accustomed to eat," literally, "I am acustomed, I eat."

None of these devices fullfils all the uses of the infinitive, and hence they are all inferior to it.

In languages which lack formal elements, the deficiency must be supplied by the mind. Words are merely placed in juxtaposition, and their relationship guessed at. Thus, when a language constructs its cases merely by prefixing prepositions to the unaltered noun, there is no grammatical form; in the Mbaya language *e-tiboa* is translated "through me," but it is really "I, through;" *l'emani*, is rendered "he wishes," but it is strictly "he, wish."

In such languages the same collocation of words often corresponds to quite different meanings, as the precise relation of the thoughts is not defined by any formal elements. This is well illustrated in the Tupi tongue. The word *uba* is "father;" with the pronoun of the third person prefixed it is *tuba*, literally "he, father." This may mean either "his father," or "he is a father," or "he has a father," just as the sense of the rest of the sentence requires.

Certainly a language which thus leaves confounded together ideas so distinct as these, is inferior to one which discriminates them; and this is why the formal elements of a tongue are so important to intellectual growth. The Tupis may be an energetic and skillful people, but with their language they can never take a position as masters in the realm of ideas.

The absence of the passive in most, if not all, American tongues is supplied by similar inadequate collocations of words. In Huasteca, for example, *nana tanin tahjal*, is translated "I

am treated by him;" actually it is, "I, me, treats he." This is not a passive, but simply the idea of the Ego connected with the idea of another acting upon it.

This is vastly below the level of inflected speech; for it cannot be too strenuously maintained that the grammatical relations of spoken language are the more perfect and favorable to intellectual growth, the more closely they correspond to the logical relations of thought.

Sometimes what appears as inflection turns out on examination to be merely adjunction. Thus in the Mbaya tongue there are such verbal forms as *daladi*, thou wilt throw, *nilabuite*, he has spun, when the *d* is the sign of the future, and the *n* of the perfect. These look like inflections; but in fact *d*, is simply a relic of *quide*, hereafter, later, and *n* stands in the same relation to *quine*, which means "and also."

To become true formal elements, all such adjuncts must have completely lost their independent signification; because if they retain it, their material content requires qualification and relation just as any other stem word.

A few American languages may have reached this stage. In the Mexican there are the terminals *ya* or *a* in the imperfect, the augment *o* in the preterit, and others in the future. In the Tamanaca the present ends in *a*, the preterit in *e*, the future in *c* "There is nothing in either of these tongues to show that these tense signs have independent meaning, and therefore there is no reason why they should not be classed with those of the Greek and Sanscrit as true inflectional elements."*

§ 13. Psychological Origin of Incorporation.

This Incorporative plan, which may be considered as distinctive of the American stock of languages, is explained in its psychological origin by Humboldt, as the result of an *exaltation of the imaginative over the intellectual elements of mind.* By this method, the linguistic faculty strives to present to the understanding the whole thought in the most compact form possible, thus to facilitate its comprehension; and this it does, because a

* "Der Mexikanischen kann man am Verbum, in welchem die Zeiten durch einzelne Endbuchstaben und zum Theil offenbar symbolisch bezeichnet werden, Flexionen und ein gewisses Streben nach Sanskritischer Worteinheit nicht absprechen." *Ueber die Verschiedenheit*, etc., *Werke*, Bd. vi, s. 176.

thought presented in one word is more vivid and stimulating to the imagination, more individual and picturesque, than when narrated in a number of words.*

But the mistake must not be made of supposing that Incorporation is a *creative act* of the language-sense, or that its products, the compounds that it builds, are real words. Humboldt was careful to impress this distinction, and calls such incorporated compounds examples of *collocation* (Zusammensetzung), not of *synthesis* (Zusammenfassung). On this ground, he doubted, and with justice, the assertion of Duponceau, that the long words of the Lenape (Delaware) dialect are formed by an arbitrary selection of the phonetic parts of a number of words, without reference to the radical syllables.† He insisted, as is really the case, that in all instances the significant syllable or syllables are retained.

§ 14. Effect of Incorporation on Compound Sentences.

As has been seen, the theory of Incorporation is to express the whole proposition, as nearly as possible, in one word; and what part of it cannot be thus expressed, is left without any syntax whatever. Not only does this apply to individual words in a sentence, but it extends to the various clauses of a compound sentence, such as in Aryan languages show their relation to the leading clauses by means of prepositions, conjunctions and relative pronouns.

When the methods are analyzed by which the major and minor clauses are assigned their respective values in these tongues, it is very plain what difficulties of expression the system of Incorporation involves. Few of them have any true connecting word of either of the three classes above mentioned. They depend on scarcely veiled material words, simply placed in juxtaposition.

It is probable that the prepositions and conjunctions of all

* "Daher ist das Einschliessen in Ein Wort mehr Sache der Einbildungskraft, die Trennung mehr die des Verstandes." *Ueber die Verschiedenheit*, etc., s. 327. Compare also, s. 326 and 166. Steinthal points out the disadvantages of the incorporative plan and puts it lower than the isolating system of the Chinese; but fails to recognize its many and striking advantages. See his remarks, "Ueber das Wesen und Werth der Einverleibungsmethode," in his *Charakteristik der haupt. Typen des Sprachbaues*, s. 214.

† *Ueber die Verschiedenheit*, etc., in *Werke*, Bd. vi, ss. 323 sqq.

languages were at first significant words, and the degree to which they have lost their primary significations and have become purely formal elements expressing relation, is one of the measures of the grammatical evolution of a tongue. In most American idioms their origin from substantives is readily recognizable. Frequently these substantives refer to parts of the body, and this, in passing, suggests the antiquity of this class of words and their value in comparison.

In Maya *tan* means in, toward, among; but it is also the breast or front of the body. The Mexican has three classes of prepositions—the first, whose origin from a substantive cannot be detected; the second, where an unknown and a known element are combined; the third, where the substantive is perfectly clear. An example of the last mentioned is *itic*, in, compounded of *ite*, belly, and the locative particle *c*; the phrase *ilhuicatl itic*, in heaven, is literally "in the belly of heaven." Precisely the same is the Cakchiquel *pamcah*, literally, "belly, heaven"=in heaven. In Mexican, *notepotzco* is "behind me," literally, "my back, at;" this corresponds again to the Cakchiquel *chuih*, behind me, from *chi*, at, *u*, my, *vih*, shoulder-blades. The Mixteca prepositions present the crude nature of their origin without disguise, *chisi huahi*, belly, house—that is, in front of the house; *sata huahi*, back, house—behind the house.

The conjunctions are equally transparent. "And" in Maya is *yetel*, in Mexican *ihuan*. One would suppose that such an indispensable connective would long since have been worn down to an insoluble entity. On the contrary, both these words retain their perfect material meaning. *Yetel* is a compound of *y*, his, *et*, companion, and *el*, the definite termination of nouns. *Ihuan* is the possessive, *i*, and *huan*, associate, companion, used also as a termination to form a certain class of plurals.

The deficiency in true conjunctions and relative pronouns is met in many American languages by a reversal of the plan of expression with us. The relative clause becomes the principal one. There is a certain logical justice in this; for, if we reflect, it will appear evident that the major proposition is, in our construction, presented as one of the conditions of the minor. "I shall drown, if I fall in the water," means that, of the various results of my falling in the water, one of them will be that I

shall drown. "I followed the road which you described," means that you described a road, and one of the results of this act of yours was that I followed it.

This explains the plan of constructing compound sentences in Qquichua. Instead of saying "I shall follow the road which you describe," the construction is "You describe, this road I shall follow;" and instead of "I shall drown if I fall in the water," it would be, "I fall in the water, I shall drown."

The Mexican language introduces the relative clause by the word *in*, which is an article and demonstrative pronoun, or, if the proposition is a conditional one, by *intla*, which really signifies "within this," and conveys the sense that the major is included within the conditions of the minor clause. The Cakchiquel conditional particle is *vue*, if, which appears to be simply the particle of affirmation "yes," employed to give extension to the minor clause, which, as a rule, is placed first.

Or a conventional arrangement of words may be adopted which will convey the idea of certain dependent clauses, as those expressing similitude, as is often the case in Mexican.

§ 15. The Dual in American Languages.

In his admirable philosophical examination of the dual number in language, Humboldt laid the foundation of a linguistic theory of numerals which has not yet received the development it merits. Here he brings into view the dual and plural endings of a list of American languages, and explains the motives on which they base the inclusive and exclusive plurals so common among them. It is, in fact, a species of pronominal dual confined to the first person in the plural.

This, he goes on to say, is by no means the only dual in these tongues. Some of them express both the other classes of duals which he names. Thus, the Totonaca has duals for all objects which appear as pairs in nature, as the eyes, the ears, the hands, etc.; while the Araucanian equals the Sanscrit in extending the grammatical expression of the dual through all parts of speech where it can find proper application.*

* See the essay, *Ueber den Dualis*, *Gesammelte Werke*, Bd. vi, ss. 562–596.

§ 16. HUMBOLDT'S ESSAY ON THE AMERICAN VERB.

The essay on the American verb translated in the following pages has never previously appeared in print, either in German or English. The original MS. is in the Royal Library at Berlin, whence I obtained a transcript. The author alludes to this essay in several passages of his printed works, most fully in his "Letter to M. Abel-Remusat" (1826), in which he says:

" A few years ago, I read before the Berlin Academy a memoir, which has not been printed, in which I compared a number of American languages with each other, solely with regard to the manner in which they express the verb as uniting the subject with the attribute in the proposition, and from this point of view I assigned them to various classes. As this trait proves to what degree a language possesses grammatical forms, or is near to possessing them, it is decisive of the whole grammar of a tongue."

On reading the memoir, I was so much impressed with the acuteness and justness of its analysis of American verbal forms that I prepared the translation which I now submit.

In the more recent studies of the American verb which have appeared from the pens of Friedrich Müller, J. Hammond Trumbull and Lucien Adam, we have the same central element of speech subjected to critical investigation at able hands. But it seems to me that none of them has approached the topic with the broad, philosophic conceptions which impress the reader in this essay of Humboldt's. Although sixty years and more have elapsed since it was written, I am confident that it will provide ample food for thought to the earnest student of language.

On the Verb in American Languages. By Wilhelm von Humboldt. Translated from the unpublished original. By D. G. Brinton, M.D.

You recently had the goodness to give an appreciative hearing to my essay on The Origin of Grammatical Forms.

I desire to-day to apply the principles which I then stated in general to a particular grammatical point through a series of languages. I choose those of America as best suited to such a purpose, and select the Verb as the most important part of speech, and the central point of every language. Without entering into an analysis of the different parts of the verb, I shall confine myself to that which constitutes its peculiar verbal character—the union of the subject and predicate of the sentence by means of the notion of Being. This alone forms the essence of the verb; all other relations, as of persons, tenses, modes and classes, are merely secondary properties.

The question to be answered is therefore:—

Through what form of grammatical notation do the languages under consideration indicate that subject and predicate are to be united by means of the notion of Being?

I believe I have shown with sufficient clearness that a language may have a great diversity of apparent forms, and may express all grammatical relations with definiteness, and yet when taken as a whole it may lack true grammatical form. From this arises an essential and real graduated difference between languages. This difference, however, has nothing to do with the question whether particular languages employ exclusively agglutination or inflection, as all began with agglutination; but in the languages of the higher class, it became in its effects on the mind, identical with inflection.

As languages of the higher class, one has but to name the cultivated idioms of Asia and Europe, Sanscrit, Greek and Latin, in order to apply to them the above statement. It is still more necessary, however, to understand thoroughly the structure of those languages which are on a lower plane, partly because this will convince us of the correctness of the classification, partly because these tongues are less generally known.

It is enough to take up some single leading grammatical relation. I select for this purpose the verb as the most important part of speech, with which most of the others come into relation, and which completes the formation of the sentence, the grammatical purpose of all language—and often embraces it wholly in itself. But I shall confine myself solely to that which makes the verb a verb, the characteristic notation of its peculiar verbal nature. In every language this point is the most important and the most difficult, and cannot be made too clear to throw light upon the whole of the language. Linguistic character can be ascertained through this point in the shortest and most certain manner.

The verb is the union of the subject and predicate of the sentence by means of the notion of Being; yet not of every predicate. The attribute which is united to the substance by the verb must be an energic one, a participial. The substance is represented in the verb as in motion, as connecting the Being with the energic atttribute. By means of this representation, and the peculiar nature of the attribute, the verb is distinguished from the mere logical copula, with which it is liable to be confounded if these ideas are not understood. If the verb is explained merely as a synthesis of Being with any other attribute, then the origin of the tenses cannot be wholly derived from one idea, for the idea of time alone would allow only a three-fold distinction. Moreover, in such case the true and efficient nature of the verb is misunderstood. In the sentence, "The man is good," the verb is not a synthesis of the adjective "good" with the substantive, but it is a participial of the energic attribute "to be good," which contains a condition, having beginning, middle and end, and consequently resembles an action. Fully analyzed, the sentence would be, "He is being-good." Where the substantive verb stands without a visible predicate, as in the sentence, "I am," then the verb "to be" has itself as the object of a synthesis, "I am being." But as rude nations would find this difficult to comprehend, the verb "to be" is either entirely lacking, as in many American languages, or else it has an original material sense, and is confounded with "to stand," "to give," "to eat," etc., and thus indicates Being as identical with the most familiar occupations.

The subject, the substance represented as in action, may be one independent of the speakers, or it may be identical with one of them, and this identity is expressed by the pronouns. From this arises the persons. The energic attribute may exert its action in various manners in the substance or between two substances; this gives rise to the forms or classes of verbs. Their action must be confined to a given point or period of time. The Being may be understood as definite or indefinite, etc., and in this is the origin of modes. Being is inseparably connected with the notation of time. This, united with the fixation of the point or period of time of an action, forms the tenses. No verb, therefore, can be conceived as without persons and tenses, modes and classes; yet these qualities do not constitute its essence, but arise from the latter, which itself is the synthesis brought about by the notion of Being. The signs of these qualities must be made to appear in the grammatical notation of the verb, but in such a manner that they appear dependent on its nature, making one with it.

The energic attribute, which aids in forming the verb, may be a real movement or action, as going, coming, living, working, etc., or merely a qualitative Being, as a being beautiful, good, mortal, or immortal. In the former case, we have a real attributive verb, in the latter a substantive verb, in which an attribute is considered as at rest, hence as an adjective. Although in both cases the nature of the verb is the

same, yet in many languages this difference leads to a corresponding variety in grammatical notation.

In accordance with these ideas culled from universal grammar, the forms of the conjugations in the various languages will now be considered.

I have taken as a basis for this investigation as many American languages as I thought sufficient for the purpose, and as would not make the survey oppressive by their number; but as I do not name all of them, and pay still less attention to pointing out in what other groups of languages the peculiarities named occur, it must be understood that what is here said is not intended as a characterization of American languages. This is reserved for another study.

In order to judge how closely these languages approach grammatical perfection in this point, we must take as our criterion that condition of speech where there is a class of words, which possess verbal power, and are at the same time separated by a definite form from all other parts of speech. With reference to this condition as the highest, we must arrange in various grades all other structural forms or paraphrases of the verb.

The notion of Being, which constitutes the basis and the essence of the verb, can be indicated either,

1. As expressed independently.
2. As incorporated in the verbal form as an auxiliary verb.
3. As included in the verbal form merely as an idea.

The differences of the languages under comparison can be appreciated most correctly by means of these three headings; but it must not be forgotten that any language may use the first and one of the last two methods, and that in languages which have a substantive verb conjugated with and without auxiliary verbs, all three may be employed.

I.

When the notion of Being is expressed independently.

I must except from this class all instances where the substantive verb is formed from a radical, inasmuch as this root, like any other, must assume the verbal form, and thus come under one of the two other divisions. In such case it expresses the notion of Being, either by an auxiliary, as in the German *Ich bin gewesen*, or simply in the form, as, *I am*. When it is remembered that the substantive verbs of all languages are derived from concrete conceptions and impart to these merely the general notion of Being, the above becomes still more obvious.

Now if there is no root-form for the substantive verb, and yet it is expressed independently, and not by another verbal form, this can only be done either by the position of the governing and governed words, or by linguistic elements which are not properly verbs, but only become

so by this use. In the former case the substantive verb is merely understood, in the latter it appears in a definite word, but without a fixed radical.

1. *When the notion of Being is understood.*

One of the most common forms of sentences in American languages is to bring together an adjective and a substantive, the substantive verb being omitted.

Mexican: *in Pedro qualli*, the Peter (is) good.

Totonaca: *aquit chixco*, I (am) a man.

Huasteca: *naxe uxum ibaua tzichniel*, this woman (is) not thy servant.

In the Mixteca language such expressions have a peculiar arrangement. The adjective must precede the substantive, or rather the predicate must precede the subject, as in the reverse case the words are understood separately, and are not connected into a sentence: *quadza ñaha*, the woman is bad; *ñaha quadza*, the bad woman.

In the language of the Mbayas, a sentence can be made with any verb by dropping the verbal affixes, by transposing a letter characterizing the nouns as such, appending an adjective suffix, and uniting this with an independent pronoun. The grammars of this language call this form a passive, but it is just as much a neuter, and is not a verb but a phrase. From *iigaichini*, to teach, we have *n-iigaichin-igi*, taught, and as first person *e n-iigaichin-igi*, I am taught. The initial *n* which accompanies all nouns in this language, is merely the possessive pronoun of the third person, added according to the usage of many of these tongues to leave no noun without a possessive; the termination *igi* is a particle which indicates the place where anything remains. Literally, therefore, *eniigaichinigi* means, I (am) the stopping-place of his teaching, *i. e.*, one who is taught. All affixes of mode and tense, however, may be united to this phrase, so that thus it approaches a verb.

Regarded apart from the changes through tenses and modes, the union of the subject and predicate with the substantive verb omitted, is admirably adapted to express the conjunction of two words in one idea, and as the languages which make use of it also possess the ordinary forms of conjugation, they thus possess a special expression for both the forms of verbs above referred to. We shall note this particularly in the Beto language.

When the subject is not an independent part of speech, but an affixed pronoun, the analogy of this method of notation to a verbal form increases. For this is present even when no characteristic of a tense is added, simply by the union of an attribute and a pronoun. It should be remarked once for all, however, that too much weight must not be attached to whether these elements form one word or not, as this is not an infallible criterion.

The verb cannot be considered to be present as a separate part of speech, when a verb can thus be made out of any word, not merely those stamped as verbs, but also out of those which bear the express characteristics of nouns; and therefore I include all these cases in the class under consideration. For in all these languages there is in fact no verb, but only separate elements of speech with the verb omitted. Such cases are, however, interesting, as showing the gradual approach to the verb, and the effort of the instinct of language to arrive at grammatical form.

The independent personal pronoun rarely makes an element of verbal form, as in speaking it is generally worn down to an affix. When it is used to form a verbal expression, the difference of the elements is apparent. Thus, in the Carib, *anaiaca*[1] *puin*[2] *au*[3]—I[3] (am) not a divider[1]. In that tongue, however, this placement is not applicable to every noun, but only after certain definite verbal forms, especially in negative expressions.

The Lule language confines this notation to participials, and expresses by it the condition of the action and also its time; *mil*[1] *quis*[2] *amaiciton*[3], you[1] (are) me[2] loving[3].

The affixed pronouns are either special, confined to these expressions, or if elsewhere in the tongue, are not employed with verbs, or not in this manner; or they are the pronominal affixes of the verb itself.

The Maya or Yucatecan language has a special pronoun which added to any noun forms a sentence with it, and possesses the power to add the idea of the verb; *Pedro en*, I am Pedro. But when it stands alone, without a predicate, it loses this power, as *en* alone does not mean, "I am."

In the Beto language there is, indeed, no special pronoun of this kind, as the one used is also a possessive. Its position, however, makes the difference. When it is prefixed, it is the possessive, but when suffixed it carries with it the power of the verb: *humani rru*, man I (am); *fofei rru*, bad I (am). In a similar manner this tongue forms a substantive verb, *ajoi rru*. The meaning of the root is not given, but it seems to mean something present, at hand. It is suggestive that in these phrases the accent is always on the pronoun, as if to signify that that is the important element.

It is very common in American languages to find the noun and the verb using the same pronouns, with the former to indicate possession, with the latter the subject. This might be explained by supposing that the action is regarded as the possession of the agent. But it is simpler to suppose that in each case the connection of the person with the noun and the verb is in the thoughts, and this relation is recognized in expression.

In this way the Mbaya language has a sort of descriptive conjugation;

connecting the participles with possessive pronouns; *i-iligodi*, I (am) explaining; but no doubt less definitely, "my explaining," "I to explain."

The language of the Abipones slightly alters the possessive pronouns in some persons and uses them in a similar manner: *ri-aal*, I am lazy; *yo-amkata*, he is good.

When the verbal pronoun is used in such expressions, it is entirely identical with the verb.

This is the case with the Mexican, where the verbal pronoun united to the participle forms a sentence: *ni-tlaçotlani*, I (am) a lover. This expression differs from the present indicative only in the form of the root-word, *ni-tlaçotla;* but it cannot form another tense or mode. The grammarians call such an expression a tense indicating habit. This, however, would not be a tense but a mode, and, in fact, the term rests on a misunderstanding. That such expressions indicate habit is shown by the fact that they do not apply, like the present of the verb, to the temporary action, but convey that it is a custom, or a business; not that I am loving just now, but that I am habitually a lover.

An entirely similar instance occurs in the North Guaranay language, which also permits, besides the regular conjugation, a union of the root of the verb with a pronoun, the verb being omitted. The grammarians of that tongue say that this adds extension and emphasis to the sense of the verb. The real difference, however, is that this procedure treats the verb as a noun, and the extension comes from considering the action expressed by the verb to have become a permanent quality; *a poro iuca*, I kill men (ordinary conjugation); *xe poro iuca*, I (am) a man-killer (form with the possessive pronoun); I kill men as my business.

In both these languages, therefore, what have been represented as peculiar and separated forms, tenses indicating habit, or forms of extension, are simply erroneous explanations of quite simple constructions. In Mexican the correctness of this explanation is confirmed by the forms of the vocative, which are identical with this supposed tense, *in ti tlatlacoani*, O thou sinner; literally, thou who (art) a sinner.

In the above examples the verbal power lies in the pronouns. But the Mbaya language constructs verbal sentences by adding the sign of the future to any adjective without a pronoun. This sign is *de*, or before a vowel *d: de liidi*, it will be pleasant to the taste; *d otiya*, he will be fat. I do not find other examples, and am uncertain whether other tenses and modes are thus formed. In that case the pronouns would have to be added, and the expression would lose its peculiarity, which is that the tense sign alone carries with it the notion of Being.

The Othomi language makes use in such expressions not only of the pronouns but of all the affixes of the verb, and conjugates a noun together with its article, treating it as a verbal radical: *qui-no-munti-*

maha, Thou wert the enriched. Here *no-munti* is "the enriched," and all the remaining syllables are verbal inflections. Sandoval, who wrote a grammar of the language, explains *no* as an auxiliary verb: but with the noun he calls it an article, as it is, and he evidently misunderstood the expression. It is wholly a verbal, but as this procedure can be applied to any noun whatever, such an expression is far removed from a real, well-defined verbal form.

The same language has another peculiar form with the possessive, which can only be explained by supplying an omitted verb. *Na nuhti* means "my property;" but if to this is added the abbreviated pronoun used as a verbal affix, *na-nuhti-gā*, the words mean, "this property belongs to me," or, "my property is it, mine."

In the grammatically obscure consciousness of these people, the ideas of verbal and merely pronominal expression are confounded, as also in the Brazilian language, where "my father" and "I have a father" are expressed by the same word.

The advantages which these languages derive from the formation of sentences with the verb omitted are two.

They can change any noun into a verb, or at least they can treat it as such. It is true that this can also be done by a substantive verb when one is found, but as the languages in question unite the noun to the verbal flexions, their freedom is much greater.

The second advantage is, that when it is desirable to discriminate clearly between the two kinds of verbs, the one which has at base an energic attribute, the other which merely expresses the relation of predicate to subject, a thing to its qualities, this end can be much better reached by the process described than even by the substantive verb, which, by its full verbal form, always recalls the action of an energic attribute.

Many of the languages named include in these expressions particles of time, thereby obscuring the distinction referred to. But in others this is not the case. Thus in the Maya and Beto there are two conjugations, one with the pronoun without time particles, and one with them; and as in both these tongues the present of the true conjugation has a characteristic tense sign, a separate aorist of the present is formed by the other conjugation, which our cultivated tongues cannot express so conveniently.

2. *When the notion of Being is expressed by a special word, but without a phonetic radical.*

Although the assumption here expressed sounds at first rather enigmatical, yet one can soon see that if the notion of Being is to be conveyed without a phonetic radical, it can only be done through the sign of the person, that is, in the pronoun, with or without a tense sign. This is actually the case in two languages, the Maya and the Yaruri.

We have already seen that in the Maya there is a special pronoun

which unites a predicate to the idea of person into one sentence. There is also another which by itself conveys the idea of the verb, and of which each person has the signification both of the pronoun and the substantive verb, "I" and "I am," "thou" and "thou art," etc. Not only is it so used in the present, but it can take the signs of the tenses. It is distinguished from the pronouns previously referred to in the first and second persons of both numbers only by a prefixed *t*, as follows:

	Pronouns which, with a predicate, convey a verbal idea.	Pronouns which, by themselves, possess verbal power.
Singular.		
1.	en	ten
2.	ech	tech
3.	lai lo	lai
Plural.		
1.	on	toon
2.	ex	teex
3.	ob	loob

This similarity leads to the thought that a true phonetic radical may exist in this *t*, and may induce us to consider this word not as a pronoun but as a substantive verb. But this makes no difference. The fact remains that the word is used both as a simple pronoun and also as a substantive verb. In the translation of the Lord's Prayer, the word *toon* is a simple pronoun. If *t* is a radical, it may just as well come from the pronoun. Some languages offer clear examples of this. In the Maipure the expression for the third person singular recurs with all the other persons, as if this sound meant the person, the man generally, and the first and second persons were denoted as the "I-person," "thou-person," etc. In the Achagua language the same radical occurs in all the pronouns, but does not, as in the Maipure, stand alone for the third person singular, but in it, as in the other persons, appears as an affix.

At any rate, this pronoun answers, in the Maya, all the purposes of the substantive verb, and there is no other in the language.

It is quite intelligible that in the conceptions of rude nations the idea of an object, and especially of a person, cannot be separated from the idea of his existence. This may be applied to the forms of expression above mentioned. What seems a violent and ungrammatical omission of the verb, is probably in those people an obscure association of thoughts, a non-separation of the object from its being. Probably it is from the same source that in some American languages every adjective is so considered that it includes not the idea alone, but the expression, "it is thus, and thus constituted."

In the Yaruri language the absence of a phonetic radical meaning "to be" is yet more apparent. Each person of the pronoun is a different word, and they have no single letter in common. The pronoun

which has verbal power is almost identical with the independent personal pronoun. The tense signs are prefixed to it. Thus, *que*, I am; *ri que*, I was, &c. This *ri*, however, is merely a particle which expresses that something is remote, and corresponds with our "from." *Ui-ri-di*, there was water there, literally "water far is" (from us is). The subjunctive of this substantive verb is given as *ri*, "if I were." This means, however, "in," and is a particle. The notion of Being is added, as in the pronoun; and the ideas, "in the being," and "if I were," pass into each other.

Strictly speaking, both the verbal notations here expressed are identical with those already mentioned. Here also the verb is supplied by the mind. The difference is that in the latter case the pronouns alone signify being, and contain this notion in themselves, whereas in the other cases this notion arises from the conjunction of subject and predicate. Then also in the Maya language there is a special pronoun for this sole purpose. As far as the forms go, they entirely resemble those of a true verb, and if *que* and *ten* are regarded as mere verbs substantive, one who did not examine their elements would take them to be true verbs like the Sanscrit *bhū*, the Greek *εἰμί*, and the Latin *sum*. The example of these languages thus teaches that in the analysis of the substantive verbs of other tongues it is not necessary that a common phonetic radical need be employed.

In the Huasteca language the substantive verb is replaced by affixing a tense sign to the independent pronouns; *naua itz*, I was, *tata itz*, thou wert, etc. But the case is not the same. The pronoun receives the verbal power by the suffix *itz*, and this appears only in later times to have become a sign of the preterit, and in an earlier period to have had a general sense. The mountaineers who seem to have retained the older forms of the tongue use the *itz*, not only in the preterit, but in the present and future. It was doubtless the expression of some general verbal idea, as, to be, to do, etc.

II.

The notion of Being is incorporated with the verb as an Auxiliary.

Auxiliary verbs are used only for certain tenses, or form the entire conjugation. The former arises from accidental causes having relation only to these tenses, not to the verb in general. The latter readily arises when a substantive verb offers an easy means of conjugation by uniting with another verb. Sometimes the conjugation by means of an auxiliary shows that the linguistic sense of a notion sought something beyond the person and tense signs to express the verbal power itself, and therefore had recourse to a general verb. This can, indeed, only be constituted of those elements and a radical; but the want in the language is thus supplied, once for all, and does not return with every verb.

An excellent example of this is furnished by the Maya conjugation. In an analysis of it we find an element that neither belongs to the root, nor is a person, tense or mode sign, and when their varieties and changes are compared, there is evident throughout a marked anxiety to express the peculiar verbal power in the form of the verb.

The conjugation in the Maya language is formed by affixing the pronouns and mode and tense signs to the stem. The pronoun is, according to a distinction to be noted hereafter, either the possessive pronoun or that one which, without verbal power in itself, yet receives it when a predicate is attached to it to form a sentence.

Besides this, the suffix *cah* accompanies all verbs in the present and imperfect; and the suffix *ah* accompanies all transitive verbs through the remaining tenses, except the future. Present, 1st person, sing., *canan-in-cah*, I guard; imperf. 1st pers. sing., *canan-in cah cuchi*; perf., 1st pers. sing., *in canan-t-ah*. *In* is the possessive pronoun, *cuchi* the sign of the imperfect, *t* in the perfect is a euphonic letter.

The idea of transitive verbs is here taken somewhat narrower than usual. Only those are included which govern a word outside of themselves. All others are considered intransitive, even those which of themselves are active, but either have no expressed object (as, I love, I hate, etc.), or the word which they govern is in the verb itself, as in the Greek *οἰκοδομεο*, *οἰκουρεω*. As these can govern a second accusative, the object incorporated in the verb is included in the idea they express.

The tenses of the intransitive verbs, except the present and imperfect, while they drop *ah* and the possessive pronoun, are formed with that pronoun which forms sentences with a predicate.

There are cases where not only the present omits *cah*, but where the stem, if it ends in *ah* as is often the case, drops it, and substitutes *ic*. The signification then alters, and indicates an habitual action or quality. As *ic* is the sign of the gerund, this change appears to be the transformation of the verb into a verbal, and to effect this, it must be united to that pronoun which serves as the substantive verb; *ten yacunic*, I love, properly, I am loving (habitually).

What *cah* and *ah* mean by themselves, we are not informed. Where *cah* is attached to the stem of some verbs it signifies intensity. *Ah* is as a prefix the sign of the male sex, of the inhabitant of a place, and of names derived from active verbs. Hence it seems to have meant at first person, man, and later to have become a pronoun, and finally an affix. It is noteworthy that the same difference exists between *ah* and *cah*, as between *en* and *ten*. The *c* may therefore be a radical sound. In the conjugation, *cah* is treated wholly as a verb. For in this the possessive pronoun is always prefixed; and as in the present and imperfect it is placed after the stem of the verb and before *cah*, it is evident from the difference between the two forms *canan-in-cah* and *in-canan-t-ah*, that in the former *cah*, and in the latter *canan*, are regarded as the verbs. *Canan-in-cah* is precisely as the English "I do guard."

Cah is consequently a true auxiliary verb; *ten*, when it appears in conjunction with *en* must have the notion of Being understood: *ah* appears to be of similar nature, but as it appears only in the conjugation of transitive verbs, it is a verbal sign, and thus receives its verbal power. That *cah* and *ah* do really possess this powever is evident from the fact that they are never used whenever either of the pronouns which are always associated with the notion of Being is present.

Except in the future of transitive verbs, there is no instance in the conjugation where the stem of the verb is not accompanied by one of these four syllables, all of which indicate Being, and all of which have the force of auxiliary verbs.

The future of transitive verbs not only does not take any of these syllables, but even rejects *ah* when it is the terminal syllable of the stem. In this case no other termination replaces it. On the contrary, all other verbs receive a new suffix in their future, varying as they are of one or many syllables. The nature of these suffixes has not been explained.

The definite results of this analysis are as follows:

1. The Maya language possesses in its conjugation, besides the inflection syllables of the persons and tenses, another element, which, except in the simple future of transitive verbs, distinctly carries with it the notion of Being; in the future of most verbs there is such an element, but of unknown origin, and it only fails in the future of one class of verbs.

2. This language displays an effort to express, besides the other purposes of the verb, particularly its synthetic power, which is all the more apparent as it uses different means in different cases, but all designed to accomplish the same purpose.

The Yaruri language constructs the whole of its conjugation in a yet simpler manner by means of an auxiliary verb.

The union of the pronoun and the tense sign which, as we have already seen, forms the substantive verb, affixed to the stem, completes the inflections of the one and only conjugation of attributive verbs, except that the independent pronouns are prefixed. Neither the stem nor the auxiliary words suffer any changes, except the insertion of an *n* in one person. The union remains, however, a loose one, and when person and tense are manifest by the connection, the auxiliary verb is omitted. This happens in certain verbs ending in *pa*. These, contrary to the usual rule, change in the perfect this termination to *pea*, by which the tense is made apparent, and as the person is evident from the prefixed personal pronoun, the auxiliary can be dropped without danger of obscurity.

The formation of certain tenses by means of auxiliaries is also frequent in American languages.

An optative of this nature in the Lule language has already been mentioned.

In the Mixteca tongue the imperfect is thus formed from the present, which carries with it the personal sign, and the perfect without its personal sign, a proceeding which, however rude and awkward it may be, shows a just appreciation of the peculiarity of this past tense, which expresses an action as going on, and therefore present in past time. The expression of continuous action is placed first, "I sin," then this is more precisely defined by the mark of past time, "this was so;" *Yo-dzatevain-di-ni-cuvui*. *Yo* is the sign of the present, *ni* of the preterit, *di* is the pronoun; the other two words, *to sin* and *to be:* "I was sinning."

The sign of the present, *yo*, is probably an abbreviation of the verb *yodzo*, I stand upon or over something, and so there is a second auxiliary in the sentence. This may often be a means of discovering the origin of tense signs, as, especially in American tongues, tenses are often formed by the union of verbs, as also occurs in Sanscrit and Greek.

The Othomi distinguishes certain past tenses, which, however, are separated by other characteristics, by a prefixed *xa*, which is called the third person singular of a substantive verb. As these tenses are precisely those in which the action must be completed, the perfect, pluperfect and future perfect, not, however, the imperfect and past aorist, such a connection is very suitable. Of this verb we have only *xa*, and there is another substantive verb *gui*, which itself takes *oca* in its conjugation.

The Totonaca language unites the perfect, in the person spoken of, with the third person singular of the future of the substantive verb, to form a future perfect. This is no completed form, but only an awkward sequence of two verbs; *yc-paxquilh-na-huan*, literally, "I have loved, it will be," = "I shall have loved."

In similar manner the substantive verb is used to form a tense of the subjunctive.

The sign of both the perfects in this tongue is the syllable *nit*, and *niy* means "to die." It is not improbable that this affix is derived from this verb. Death and destruction are suitable ideas to express the past, and some languages employ negative particles as signs of the preterit. In the Tamanaca this is not exactly the case, but the negative particle *puni* added to a word which signifies an animate thing, intimates that it has died; *papa puni*, the deceased father, literally, "father not." In the Omagua tongue the same word signifies old, dead, and not present.

In the Maipure and Carib tongues the negative particles *ma* and *spa* are also the signs of the preterit. Bopp's suggestion that the Sanscrit augment was originally *a* privative finds support in this analogy. Yet I would not speak conclusively on this point, as probably that, the Greek augment ε, and the Mexican *o*, are only lengthened sounds, intended to represent concretely the length of the past time. At any rate one must regard the negation as an actual destruction, a "been, and no longer being," not as simply a negation of the present.

III.

The notion of Being is present in the Verbal form only in idea.

In this case the verb consists only of the stem, and the person, tense, and mode signs. The former are originally pronouns, the latter particles. Before they are worn down by use to mere affixes, the three following cases may arise:

1. That all three of these elements are equally separable and loosely connected.

2. That one of the two, the person or the tense and mode signs, obtains a closer connection with the stem, and becomes formal, while the other remains loosely attached.

3. That both these are incorporated with the stem, and the whole approaches a true grammatical form, although it does not fully represent it.

Case 1st.

The only language I can instance here is that of the Omaguas, as I know no other with such a decided absence of all true grammatical forms in the verb. The independent pronouns, the stem words of the verbs, and the particles of tense and mode are merely placed together without any change, without internal connection, and apparently without fixed order; *usu*, to go; 1st pers. sing. pres. *ta usu;* 2d pers. sing. perf. *avi ene usu* (*ene* is the pronoun, *avi* the sign of the perfect). Subjunctive, 1st pers. sing. pres. *ta usu mia;* 2d pers. sing. perf. *avi epe usu mia.*

Sometimes, when a misunderstanding is not feared, the verbal stem is employed without these qualifying particles, and cannot then be distinguished from a noun. *Paolo amai amano.* The last word means "to die," but grammatically the sentence can as well be rendered, "Paul only die" (*i. e.* has died), as "Paul only dead."

It is true that the suffix *ta* changes nouns to verbs: *zhiru*, clothes, *zhiru-ta*, to clothe; but it also changes verbs to nouns, *yasai*, to cover, *yasai-ta*, a cover. This may be explained by the theory that this suffix conveys the idea *to make*, which is taken sometimes actively, sometimes passively.

According to the above, the Omagua conjugation falls in the class where an attributive is united to a pronoun and the verb is omitted; only that here definite tense syllables appear, and this brings the construction nearer to the idea of a conjugation.

Case 2d.

1. The Maipure, Abipone, Mbaya and Mocobi languages place only the personal sign in intimate connection with the verb, and allow the tense and mode signs to be loosely attached. They have therefore but one type of personal forms to be applied in every tense and mode by

means of the particles or the affixes formed from them. This type, taken alone, usually forms the present; but, accurately speaking, this name cannot be assigned it; because the signs of the other tenses are also dropped when this can be done without obscurity. *Ya-chaguani-me-yaladi.* Here the first word is in the indefinite form, though it is not the present but the perfect. The *me* is really the preposition "in;" but usage has adopted it for the subjunctive sign, and so the Spanish grammarians call it; or rather, the verb is considered to be introduced by a conjunction, "if," "as," so that it is usually not in the present but a past tense. If this is the case with the last verb, the first one must have the same tense, and so the whole phrase, without any tense sign, means, "I had helped him when I said it."

One would scarcely expect to find anything like this in cultivated languages. Yet it does occur in both Sanscrit and Greek. The now meaningless particle *sma* in Sanscrit when it follows the present changes it into a past, and in Greek *ἄν* alters the indicative into a subjunctive.

To form this general type, the Maipure makes use of the unchanged possessive pronoun, and treats nouns and verbs in the same manner. The noun must always be united to a possessive pronoun, a trait common to all the Orinoco tongues and many other American languages. In the 3d person sing., however, neither the verb nor the noun has such a pronoun, but it is to be understood; *nuani*, my son; *ani*, alone, not son, but "his son." The 3d pers. sing. of the verb is often the mere stem, without a personal sign, but that this peculiarity should also extend to the noun I have met only in this tongue. It is evident that a pronoun is considered as essential to a noun as to a verb, and although a similar usage is found in many tongues, yet it appears in none so binding. There are, indeed, some nouns which are free from the necessity of thinking them in connection with a person, but these have the suffix *ti*, which is dropped when the possessive pronoun is added; *java ti*, a hatchet, *nu java*, my hatchet. From this it is evident that *ti* does not belong to the stem, and is incompatible with the use of a possessive, hence it is the sign of the substantive, in its independent condition. The same occurs in Mexican, and the chief termination of substantives, *tli*, is almost identical in sound with that in the Maipure.

In this respect the verbal, conjugated with the personal signs, differs nothing from the noun united to its possessive pronouns. Grammatically, the form first becomes a verbal one by the added particles of tense and mode. The signification of these can generally be clearly ascertained, and thus are united closely to the stem.

The particles which the language of the Abipones uses to form the general verbal type are quite different from the possessives. The tense and mode particles have elsewhere in the tongue independent meanings. Thus *kan*, the sign of the perfect, means a thing which has been, time that has past.

In the language of the Mocobis the personal signs consist merely in letters, prefixed and suffixed, and have no apparent relationship to the pronouns. By affixing these letters, phonetic changes take place so *that the stem is combined with them into one form.*

Among the tense signs, a prefixed *l* indicates a past time, a suffixed *o*, the future; but the others are independent particles, loosely attached to the stem.

I have already shown how the Mbaya language conjugates adjectives with the independent pronoun, and participles with the possessive pronoun. The signs used in the conjugation proper of the attributive verb, do not appear elsewhere in the tongue, and must have descended from an older period of its existence.

In the tense and mode signs it is easily perceived how descriptive phrases pass into true forms. For the imperfect and pluperfect the speaker can choose among a number of particles, all of which indicate past time. The modes have definite signs, but these are merely appended, and some have separate significations. The future and perfect have not merely fixed particles, but these are worn down to one letter, so that the stem is actually incorporated with them.

2. In the languages heretofore considered the personal signs added to the word make up the conjugation, and the other signs are attached loosely and externally. The reverse of this, though not perfectly so, appears in the Lule language. The tense and mode signs, often of but one letter, are immediately and firmly attached to the stem, and the pronouns are affixed to this to complete the conjugation. These pronouns are, however, the ordinary possessives, so that noun and verb become in a measure identical; thus, *camc* means both "I eat" and "my food;" *cumuee,* "I marry" and "my wife;" only in a few examples are the verbal pronouns distinct from the possessives.

In this case, therefore, the personal signs are independent elements, occurring elsewhere in the language, while the tense and mode signs are true affixes.

The inflection-syllables form with the stem real verbal forms, and so far the conjugation of this language belongs to the third case. But each of the elements has its fixed position, and as soon as one has the key to the combination, he can recognize and separate them at once.

Reasons which it would require too much space to set forth render it probable that all the tense signs are really auxiliary verbs or come from them. This is evident of the optative, as has already been shown. The present only is simple, as it has no tense sign.

Slight differences are found between the personal signs of some tenses, so that these tenses can be distinguished by them, a trait usually seen only in tongues so far cultivated that the grammatical forms have undergone such changes as no longer to present simple and uniform combinations. Equally curious is the regular omission of the tense sign of past time in the third person plural only. Although, except in

this case and that of the present, each tense has its definite sign, inserted between the stem and the personal sign, yet there are, besides these, various particles expressing past time, which can accompany the usual tense form, so that there is a double sign of time, one in the word itself and one loosely attached to it.

The languages of the Mbayas, Abipones, Mocobis and Lules are closely allied both in words and in some grammatical forms. It is all the more extraordinary, therefore, to find the last-mentioned pursuing a method in the structure of its verb which is almost totally opposed to that in the other three tongues.

Case 3d.

The languages of this class approach in their conjugations those of the more cultivated tongues, in which each verbal inflection has a fixed and independent form. Both the person, the tense and the mode signs are united to the stem, in such a manner that none of the three can be said to be either less or more loosely attached than the others.

All the conjugations about to be discussed lack, however, that fixity of form which grammatically satisfies the mind.

The elements are placed definitely and regularly one by the other, but are not incorporated into each other, and are therefore readily recognizable.

They are found, moreover, outside of the verb elsewhere in the language either without any change or with slight differences of sound; the personal signs as pronouns, the other affixes as particles.

The composition of the verb is separable, and may receive into itself other parts of speech.

No American language is free from these drawbacks to perfection of form in the conjugations. In some all three are found; in most the first and last. In really grammatically developed tongues, as in the Sanscrit, Greek, Latin and German, none of these imperfections exists. The verb includes in itself no part of its object, the affixes modifying the stem have lost all independent life, and the analysis of the formal elements becomes a difficult philological task, which often fails and only rarely can be fully proved.

I shall discriminate in regard to the conjugations about to be considered that which is an approach toward a fixed form from the intentional separation of the form to insert a governed word.

1. Approach toward a Fixed Form.

In the Mixteca language, the personal sign is the unchanged possessive pronoun. If the verb is governed by a noun in the third person, the possessive is dropped. It is left to the speaker to choose whether he designates the person, either by prefixing the personal pronoun or suffixing the possessive. The tense signs are prefixed syllables, but the

perfect and future signs are altogether different from those of the present, and materially alter the verbal stem.

The Beto language prefixes the personal signs and also the possessive pronouns to the nouns. As the latter are not fully known, we cannot judge of their identity with the verbal pronouns. The latter do not seem to differ much from the personal pronouns. The tense signs are easily recognized suffixes.

Another conjugation of the same language, by the suffixed pronoun without tense signs, and with the verb omitted, has been mentioned above (I, 1), as forming a substantive verb.

A second substantive verb arises from the conjugation above explained, with the tense signs.

These two forms may also be combined, and this illustrates with what superfluous fullness grammatical forms spring up even among rude nations. The conjugation with the tense sign is changed by a participial suffix into a verbal, and then the pronoun is suffixed, as in the conjugation without the tense sign. The latter, therefore, stands twice in the form. The pronoun used in the conjugation with tense signs may also be prefixed to a simple adjective, and the pronoun used in the conjugation without tense sign is suffixed to this, and the participial ending is then added. This is treated as a verb with the substantive verb understood. But sometimes the verb "to be" in the form without tense signs is added, and then the whole form contains the pronoun three times, without gaining thereby any additional meaning.

The Carib conjugation seems to have arisen from the forms of many dialects or epochs, and is therefore more complicated and formal, and less easy to analyze.

The personal signs are prefixed. In the substantive verb there are two classes, of which only one is also common to attributive verbs. The other indicates in the verb "to be" also the connection of persons with the infinitive and gerund, and is therefore of the nature of a possessive. It may also be that when it is combined with other tenses, the notion among these nations is altogether a substantial one, as we have already seen with the subjunctive.

The stem often receives the addition *r* or *ri*, the meaning of which is not known.

The structure of the Tamanaca conjugation also reveals a combination of at least two separate structures. Some tenses use as their personal signs entire pronouns, almost identical with the personals. Other tenses merely change the initial letter of the verb, while there is little similarity between these affixes and the pronouns. In the plural some of the persons insert a syllable between the verb and the tense sign.

The tense signs are suffixed, and consist merely of terminal letters or syllables, except two true particles, which distinguish the continued present from the present aorist.

There are an initial *y* and a *t* occasionally appearing in all persons, of which we can only say that they are not radicals.

The conjugation of this language, therefore, consists of elements not readily analyzed.

The Huasteca language prefixes the possessive pronouns as personal signs. It may also drop them, and use in their stead the independent pronouns; or may combine both; or may use abbreviated personals; so that there is a prevailing arbitrariness in this part of the verbal form.

The tense signs are usually suffixes; but in the future they are prefixes, which are incorporated with the personal sign placed between them and the stem. They consist of simple sounds, of no independent signification. But the particles of the imperative are so separable that when this mode is preceded by an adverb, they attach themselves to it.

The Othomi language does not make use of the possessive pronouns in the conjugation, but suffixes abbreviated forms of the personals, or else prefixes others of special form, but identical in many letters and syllables with the personals. In the present condition of the language the suffixes are used only with the substantive verb; in the attributive verb, however, they may have been driven forward by the governed pronouns suffixed. Every verbal inflection may also take, besides its pronominal prefix, also the unabreviated personal pronoun in front, or the abbreviated one after it.

The tense signs consist principally of single vowels, by means of which the pronominal prefixes are attached to the stem. The imperfect and pluperfect alone have besides this a loosely attached particle. The past tenses possess a prefix, which we have already seen appears to have been derived from an auxiliary verb.

In the third person of some tenses in certain verbs the stem undergoes a change of its initial letters, which appears to transform these inflections into verbal adjectives, an instance of the confusion of the ideas of noun and verb common in all these languages.

The Mexican language possesses a peculiar class of verbal pronouns which form the personal signs. This pronoun is similar to the personal in its consonants, but has a vowel of its own. It is a prefix. The plural is marked by the accent, or by a special termination. This personal sign is inseparable from the verb, but the speaker may also prefix the independent personal pronoun.

The tense signs are all without signification, being single letters or syllables. The perfect is marked not so much by an affix, as by changing, the termination of the verb in various ways, but chiefly by shortening and strengthening the sound. All tense designations are placed at the end of the word, except the augment for past time. If by augment we mean a vowel sound prefixed to the verb in certain tenses in addition to their usual signs, then the Mexican is the only American language which possesses one.

The modes are designated by loosely attached particles, also by a different structure of the tenses, and in the second person a peculiar pronoun.

Thus the Mexican conjugation consists of true verbal forms, not of separate parts of speech of independent significance; but the elements of these forms are easily recognizable, and can be reached without difficulty.

The most difficult to analyze, and hence the most nearly approaching our conjugations, is that of the Totonaca language.

The personal signs differ from the pronouns. That of the 2d pers. sing. is not easily recognized, and several forms of it must be assumed. Its position as a prefix or suffix differs, and it is variously located with reference to the other verbal signs. Still more difficult is it to distinguish the tense signs. There are three different systems of prefixes and suffixes in the conjugation, and the plan on which these are combined with each other serves to distinguish the tense. But only a few of these affixes really appear to designate tense; of the others this may be suspected at best, and of others again it is improbable.

Thus there are verbal affixes which cannot be considered to designate either persons, modes or tenses.

The stem undergoes little change, but the attaching of the affixes to it renders it impossible to apply the same scheme to all verbs, and hence leads to a division of them into three conjugations.

Some tenses have two different forms, without any change in signification.

2. Divisibility of Verbal Forms to allow the insertion of governed parts of speech.

Of the Mixteca tongue it cannot exactly be said that it divides the essential parts of the verbal form to allow the insertion of the governed object. As a rule, the object is merely appended, and where it appears in the form itself, it is inserted between the stem and the suffixed pronoun. The latter is, however, no necessary part of the form, as it is dropped when the verb is governed by a noun, and can always be replaced by prefixing the indefinite pronoun.

Nor is it mentioned that the Beto language includes the object in the verb.

The Carib tongue unites the governed pronoun with the verbal form, and in some cases the personal sign is thus displaced. But here the object is not inserted in the middle, but is prefixed or suffixed.

Our information about the Tamanaca language discloses nothing on this point.

In the Huasteca, the governed pronoun separates sometimes the last, sometimes the first syllable of the inflectional form from the stem.

The Othomi merely attaches the governed words closely to the verbal form, in this resembling the Mixteca.

The Mexican language is that which has developed this peculiarity to the greatest degree. The governed noun is placed in the middle of the verb; or, if this is not done, a pronoun representing it is inserted.

If there are two objects, an accusative and a dative, then two corresponding pronouns are inserted; and if no object is named, but the verb is of that class which is followed by an immediate or remote object, or both, then two indefinite pronouns appear in the verb. The Mexican verb therefore, expresses either a complete sentence, or else a complete scheme of one, which merely requires to be filled out. It says, in one word, "I give something to somebody," *nititlamaca*, and then defines what it is and to whom.

It follows necessarily that a part of the verbal form is fluctuating according to the sense and connection of the sentence, and that the governing pronoun stands sometimes immediately before the verb, and sometimes is separated from it by indefinite pronouns or even nouns.

In the Totonaca language, the prefixes and suffixes make room for the governed words between themselves and the stem.

This examination of the languages whose conjugations approach a fixed form, shows clearly that this fixedness is seriously shaken precisely where it is most important, through this insertion of the governed words.

Now if we reflect on the structure of the various verbal forms here analyzed, certain general conclusions are reached, which are calculated to throw light upon the whole organism of these languages.

The leading and governing part of speech in them is the Pronoun; every subject of discourse is connected with the idea of Personality.

Noun and Verb are not separated; they first become so through the pronouns attached to them.

The employment of the Pronoun is two-fold, one applying to the Noun, the second to the Verb. Both, however, convey the idea of belonging to a person; in the noun appearing as Possession, in the verb as Energy. But it is on this point, on whether these ideas are confused and obscure, or whether they are defined and clear, that the grammatical perfection of a language depends. The just discrimination of the kinds of pronouns is therefore conclusive, and in this respect we must yield the decided pre-eminence to the Mexican.

It follows that the speaker must constantly make up his verbs, instead of using those already on hand; and also that the structure of the verb must be identical throughout the language, that there must be only one conjugation, and that the verbs, except a few irregular ones, can possess no peculiarities.

This is different in the Greek, Latin and ancient Indian. In those tongues many verbs must be studied separately, as they have numerous exceptions, phonetic changes, deficiencies, etc., and in other respects carry with them a marked individuality.

The difference between these cultivated and those rude languages is chiefly merely one of time, and of the more or less fortunate mixture

of dialects; though it certainly also depends in a measure on the original mental powers of the nations.

Those whose languages we have here analyzed are, in speaking, constantly putting together elementary parts; they connect nothing firmly, because they follow the changing requirements of the moment, joining together only what these requirements demand, and often leave connected through habit, that which clear thinking would necessarily divide.

Hence no just division of words can arise, such as is demanded by accurate and appropriate thought, which requires that each word must have a fixed and certain content and a defined grammatical form, and as is also demanded by the highest phonetic laws.

Nations richly endowed in mind and sense will have an instinct for such correct divisions; the incessant moving to and fro of elementary parts of speech will be distasteful to them; they will seek true individuality in the words they use; therefore they will connect them firmly, they will not accumulate too much in one, and they will only leave that connected which is so in thought, and not merely in usage or habit.

Notes (by the translator) on the various American Tribes and Languages mentioned by Humboldt in the preceding Memoir.

Abipones.—A tribe formerly residing on the broad grassy plains known as *El Gran Chaco*, west of the Parana river and on the right bank of the Rio Vermejo. They are a nomadic, hunting people, and are related by language closely to the Mocobis and Tobas, more remotely to the Mbayas. The Jesuit, Father Jose Brigniel, wrote an *Arte y Vocabulario de la Lengua Abipona*, which has not been published.

Achaguas.—A small tribe formerly living in Venezuela, between the Apure and Meta rivers. They are mentioned by Piedrahita as an intelligent people. Aristides Rojas says they are now extinct (*Estudios Indigenas*, p. 214. Caracas, 1878).

Beto.—Usually spelled *Betoi or Betoya.* They live on the upper waters of the Meta river in Colombia and are related to the Yaruris.

Caribs.—This widely extended stock occupied much of the northern coast of South America and had planted colonies on many of the Antilles. It is believed that they are distantly connected with the Tupis and Guaranis.

Guaranis.—The name of a number of affiliated tribes in Southern Brazil, Paraguay, Uruguay and the Argentine Republic. The Tupis of Brazil are a branch of the Guaranis.

Huastecas.—A northern colony of the great Maya stock of Yucatan, dwelling in the province of Tampico on the river Panuco. At the time of the discovery they were an important and cultured nation.

Lule.—One of the nations of *El Gran Chaco*, west of the Parana river. The *Arte y Vocabulario de la Lengua Lule y Tonocote*, by Father Antonio Machoni de Cerdeña (Madrid, 1732), was republished with a careful ethnographic introduction by J. M. Larsen, at Buenos Ayres, 1877.

Maipures.—Tribes of various dialects who live on both sides of the Orinoco river where it forms the boundary between Venezuela and New Granada, about 5° N. lat.

Mayas.—Natives of Yucatan, and the most highly developed of any of the American nations. Related dialects are spoken in Guatemala, in Tabasco, and by the Huastecas.

Mbayas.—A people of the *Gran Chaco* in the northern part of the Argentine Republic, and distantly related to the Abipones.

Mexican.—Otherwise called the Nahuatl or Aztec language. Spoken in the greatest purity in the valley of Mexico, it extended from the Gulf of Mexico to the Pacific, and along the latter from Sonora to Guatemala, with few interruptions.

Mixtecas.—A tribe speaking several dialects living in the State of Oaxaca, Mexico.

Mocobis.—One of the four principal nations who formerly occupied *El Gran Chaco*, west of the Parana river. By some the name is spelled *Mbocoby*.

Omaguas.—Once a nation of considerable extent and culture between the Marañon and the Orinoco.

Othomis.—A tribe resident near San Louis Potosi, Mexico, and neighboring parts. Their proper name is said to be *Hiā-hiū*. Their language is monosyllabic and nasal.

Tamanacas.—These dwell on the right bank of the Upper Orinoco, and are connected by dialect with the Carib stock on the one hand and the Guaranay on the other.

Totonacas.—A nation asserted by Pimentel to speak a mixed

language (Nahuatl and Maya) dwelling in the southern portion of the Province of Vera Cruz, Mexico, and parts adjacent.

Tupis.—The natives of the eastern area of Brazil, related to the Guaranis of the south and perhaps to the Caribs of the north. The *Lingoa Geral* of Brazil is a corrupt Tupi.

Yaruris.—Residents on the upper streams of the Meta river in New Granada, related to the Betoi.

Stated Meeting, March 20, 1885.

Present, 12 members.

Curator, Dr. HORN, in the Chair.

Mr. W. W. Jefferis, a new member, was presented to the Chair, and took his seat.

Donations for the Library were received from the Kaiserliche Akademie der Wissenschaften; Prof. F. Reuleaux, of Vienna; the Zoölogische Anzeiger; the Statistika Central Byrån; the Nordesk Oldkyndighed og Historie Selskab; Mr. Alph. Dubois, of Bruxelles; the Real Academia de la Historia at Madrid: the Instituto y Observatorio de Marina de San-Fernando; the R. Accademia dei Lincei, at Rome; the Société de Geographie, at Paris; the Revue Politique; the Meteorological Council; the Cambridge Philological Society; the Journal of Forestry; London Nature; the Massachusetts Historical Society; the American Philological Association, at Cambridge; the Essex Institute; the American Antiquarian Society, at Worcester; the Connecticut Academy of Arts and Sciences; the American Chemical Journal; the Cornell University; the New Jersey Historical Society; the Franklin Institute; the College of Pharmacy; the Pennsylvania Historical Society; the Commission for the Erection of the Public Buildings of Philadelphia; Mr. Henry Phillips, Jr.; Mr. Burnet Landreth; the Johns Hopkins University; the United States Fish Commission; the United States Geological Survey; the Smithsonian Institu-

tion; the Mercantile Library Association of San Francisco, and the Escola de Minas di Ouro Preto, at Rio de Janeiro.

Acknowledgments for No. 117 were read from the Wyoming Historical and Geological Society; New Bedford Public Library; University of California; Cornell University; Kansas State Historical Society; Dr. Persifor Frazer; Scientific Library, U. S. Patent Office (Transactions XIV, XV, XVI, i); Young Men's Library, Buffalo, N. Y. (Proceedings 96–117; Transactions XIV, XV, XVI, i).

Letters of envoy were read from the Meteorological office (London, England); publishers of Nature (London, England) and the U. S. Geological Survey (Washington, D. C.).

Deaths of the following members were announced:

George Whitney (Philadelphia), born 1815, died March 6, 1885.

Prof. Ellerslie Wallace, M.D. (Philadelphia), born 1819, died March 9, 1885.

Titian R. Peale (Philadelphia), born October 10, 1799, died March 13, 1885.

Frederick Theodore Frerichs (Berlin), born March 14, 1819, died March 14, 1885.

On motion, the President was authorized to appoint suitable persons to prepare obituary notices of said decedents.

A letter was read (dated Philadelphia, March 14th, 1885), from Mr. Thomas Meehan accepting the appointment as Chairman of the Committee on the Michaux legacy; from Mr. Conyers Button (dated Germantown, March 13th, 1885), requesting permission to have a photographic copy made of the portrait of Dr. Joseph Priestley, owned by the Society, which is in the Society's meeting room; likewise one from W. Curtis Taylor, Philadelphia, to the same effect. On motion the request was granted, with the promise that the original be not removed from the Society's possession.

Dr. Daniel G. Brinton read a paper on the Philosophic Grammar of American Languages, as set forth by Wilhelm Von Humboldt.

Dr. Brinton also presented a paper by Dr. H. Rink, of Copen-

hagen, on the recent Danish explorations in Greenland and their significance as to Arctic science in general.

Dr. W. H. Greene presented a paper by Prof. Oscar C. S. Carter, "On the adulterations of oils."

Pending nominations Nos. 1049 to 1054, inclusive, were read.

The rough minutes were read, and the Society adjourned by the presiding member.

April 3. This being a public holiday, Good Friday, by direction of the President no notices were issued and no meeting was held.

Stated Meeting, April 17, 1885.

Present, 20 members.

President, Mr. Fraley, in the Chair.

Prof. John M. Maisch, a newly elected member, was presented to the chair and took his seat.

Donations for the Library were received from the Geological Survey of India; the Académie Impériale des Sciences of St. Petersburg; the Société Impériale des Naturalistes at Moscow; the Magyar Tudományos Akademia at Budapesth; the Deutsche Geologische Gesellschaft, the Physikalische Gesellschaft, the Verein zur Beforderung des Gartenbaus and Dr. Severin Robinski, of Berlin; the Kaiserlichen Akademie der Wissenschaften at Vienna; the Verein für Erdkunde, the K. Sachsische Gessellschaft der Wissenschaften, the Zoölogischer Anzeiger and E. Von Meyer of Leipzig; the Neues Lausitisches Magazin; the Kaiserliche Leopoldina Carolina Akádémie der Deutschen Naturforscher at Halle; the Naturforschende Gesellschaft at Freiburg i B.; M. Clemens Winkler of Freiburg i S.; the Académie Royale and the Musée Royale d'Histoire Naturelle and Rev. A. Renard, of Bruxelles; the

Société Vaudoise des Sciences Naturelles at Lausanne; the Schweizerische Naturforschende Gesellschaft at Zurich; the Société de Physique et d'Histoire Naturelle and Mr. Henri de Saussure, of Geneva; the Royal Academies at Rome and Turin; the R. Instituto Lombardo; the Geographical, Anthropological, Antiquarian, Zoölogical Societies and the Institution Ethnographique, of Paris; the Musée Guimet; the Société de Émulation d'Abbeville; the R. Academia de la Historia at Madrid; the Secção dos Trabalhos Geologicos, of Portugal; the Geological, Zoölogical, the Royal Geographical, Astronomical and Meteorological Societies, the Society of Arts, of London; the Royal Asiatic Society of Great Britain and Ireland, Nature and Dr. John Evans, of Hemel Hempstead; the Philosophical Society of Glasgow; the Manitoba Historical and Scientific Society and Col. Scoble, of Winnipeg; Mr. Horatio Hale, of Clinton, Canada; the Massachusetts Historical Society; Rev. James Freeman Clarke, Mr. Robert C. Winthrop and Rev. Samuel A. Green, of Boston; Harvard College; the Essex Institute; the American Journal of Science; the American Chemical Society at New York; the Brooklyn Entomological Society; the Long Island and the New Jersey Historical Societies; Mr. Thomas H. Dudley, of Camden; the Academy of Natural Sciences, the Franklin Institute, the College of Pharmacy, the Board of City Trusts, the Journal of Medical Sciences, Mr. Henry Phillips, Jr., and Mr. S. Culin, of Philadelphia; Haverford College; the Johns Hopkins University and the American Oriental Society at Baltimore; the United States Naval Institute, National Museum, Bureau of Education, Geological Survey, the War Department and the Smithsonian Institution; Dr. J. W. Mallett, of Charlottesville; Mr. Jed. Hotchkiss, of Staunton; the Cincinnati Society of Natural History; Rev. Stephen D. Peet, of Chicago; Prof. Charles E. Putnam, of Davenport, Ia.; the University of Michigan; the State Historical Society of Wisconsin; Washburn College; the Colorado Scientific Society and the University of California.

Letters of envoy were received from the Brooklyn Entomo-

logical Society,* Regents of the University of the State of New York, Long Island Historical Society, Department of the Interior (Washington), Bureau of Ethnology (Washington), U. S. Geological Survey, Meteorological Office (London), Central Observatorium (St. Petersburg), R. I. Society for the Encouragement of Domestic Industry, Harvard College Observatory, Cincinnati Society* of Natural History, State Historical Society of Wisconsin, Section de travaux Géologiques de Portugal (Lisbon), Dr. J. W. Mallett, Philosophical Society of Leipzig, Magyar Tudományos Akademie, Schweizenische Gesellschaft (Bern), Physical Society of Berlin, K. Leopold-Corolin-Academy of Halle, A.-S.†, Musée Guimét.

Letters of acknowledgment were received from the University of California, Library of the U. S. Surgeon-General, Washington (116), Franklin Institute (116–117), F. Gutekunst (114, 115, 116, 117), University of Michigan, Chief Signal Officer, U. S. A. (Library Catalogue), K. Bibliothek, Berlin (114, 115), K. Leopold-Carolin-Akademie, Halle A.-S. (Trans. XVI, i; Procs. 113, 114, 115), Wisconsin Historical Society (Procs.).

Letters acknowledging receipt of diplomas were received from Dr. Charles Rau (Washington), Mr. C. C. Jones, Jr., (Augusta, Ga.), Dr. F. B. Hough (Louisville, N. Y.), Alexander G. Bell (Washington), Rev. C. W. King (Cambridge, England), Sir John Bennett Lawes (Rothamstead, England), John O. Westwood (Cambridge, England), E. Malezieux (Paris), John Evans (Hemel Hempstead, England), Prof. Hermann Kopp (Heidelberg).

Letters announcing change of addresses were read from: The Verein für Geographie und Statistik, F. a.-M., Dr. Otto Boehtlingk (Lange Strasse 13, Liepzig), Dr. Franz Ritter von Hauer (K. K. Natur-historische Hof Museum, 1, Burg ring Wien), Dr. J. W. Mallett (University of Virginia).

The deaths of the following members were announced: Col.

* On motion, these Societies were ordered to be placed on list of exchanges to receive Proceedings.

† This Society requests pp. 483—498 of No. 109, which were ordered to be sent.

James Worrall (April 1, 1885, æt. 81,) at Harrisburg, Pa.; William Elder, M. D. (April 6, 1885, æt. 79), at Washington, D.C.; Prof. C. T. Siebold (April 8, 1885, æt. 81), at Munich, Bavaria.

On motion, the President was authorized at his discretion to appoint proper persons to prepare obituary notices of decedents.

The President stated to the Society that, in pursuance of the resolution adopted March 20th, he had appointed the following gentlemen to prepare obituary notices of the members whose decease was then announced: Dr. DaCosta for Prof. Ellerslie Wallace; Mr. Frederick Graff for Titian R. Peale, and Mr. William Sellers for George Whitney.

Mr. W. Curtis Taylor exhibited some composite photographs on the Galton method, and explained the theory and process of their manufacture.

Prof. F. A. Genth presented a paper entitled "Contributions from the Laboratory of the University of Pennsylvania, No. XXIII. On the *Vanadates* and *Iodyrite*, from Lake Valley, Sierra County, New Mexico, by F. A. Genth and Gerhard vom Rath."

Prof. Cope communicated a paper on some points in Mexican Geology and Zoölogy, and also a paper on some new Eocene Vertebrata.

Prof. P. E. Chase presented (by mail) a proof-sheet of a paper entitled "Further Experiments in Weather Forecast" (to appear in the Journal of the Franklin Institute for May, 1885). Also a paper on the Chase-Maxwell Ratio.

The election of members was postponed to October 16th.

The President reported that he had received and paid over to the Treasurer, $132.44, the interest on the Michaux legacy due April 1st, 1885.

The Committee on Finance reported that there were sufficient funds in hand for the preparation of the Zeisberger Lenape Dictionary for the press, if the Society should order it to be published.

On motion of Mr. J. Sergeant Price, it was resolved that the consideration of the subject should be postponed until some

estimate of the whole cost of its publication should be furnished to the Committee.

Mr. J. Sergeant Price from the Committee on the Michaux legacy, reported that the Michaux lectures would be delivered as usual at the Horticultural Hall, in Fairmount Park, beginning to-morrow, and presented the following synopsis of the prepared course:

Free lectures in Fairmount Park on Botany and Sylviculture, on Saturdays, at 4 o'clock. Prof. J. T. Rothrock will deliver his usual course of lectures on Botany and Sylviculture, in Horticultural Hall, on the following Saturdays, at 4 P. M.

April 18. Our domestic foes, Bacteria.
25. Our domestic foes, Bacteria.
May 2. Evolution in plants.
9. Fate in forests.
16. New facts in botany.
23. Forests in civilization.
30. Plant freaks.
Sept. 12. Famous trees.
19. Unwelcome plants.
26. Statistics of forestry.
Oct. 3. Forest Laws.
10. Peculiar Woods.
17. Our park.
24. Food adulterations.

The rough minutes were read, and the Society was adjourned by the President.

On Composite Photography. By W. Curtis Taylor.

(Read before the American Philosophical Society, April 17, 1885.)

Composite Photography is the combination of the images of a number of allied objects in such a manner as to produce one photographic impression embodying the effects of all. There are several ways of accomplishing this, but the one to be described to-night is perhaps the simplest and surest.

By this process the common characteristics of every group of related

forms may be represented with an accuracy difficult to attain by any other means. The experiments in this department of photography were originated by Francis Galton, F.R.S., to illustrate pathological inquiry; and they have excited great interest, especially among biologists, wherever they have been introduced. Dr. Billings of the Army Museum at Washington is doing excellent work, by this means, in photographing types of crania. Prof. Pumpelly of Newport, R. I., is experimenting with living heads. Our townsman, Mr. W. R. Furness, in connection with a certain historical research, was the first in this city, I believe, to apply this process. Besides these named I know of no others in cur country working up this problem.

By the method brought before you to-night, the objects to be combined are first photographed to one size and the unmounted prints are fitted one over another—eyes to eyes and mouth to mouth. In order to make this adjustment accurately, a light open frame, perforated at each corner with a small hole, is made to fit on a block having corresponding pins on its corners. The frame bears cross threads agreeing with the lines of the eyes and mouth of the picture and with the average distances apart of the eyes. This frame, apart from the block, is placed on the first print, and the threads being brought into correspondence with the features named, punctures are made in the print, through the holes in the frame, and the print is then slid upon the pins in the block. All the prints are adjusted to their place on the block in this way. They are then successively exposed before the camera for such a proportion of time, each, as the number of prints may indicate. For example, if sixty seconds were required for an ordinary exposure, twelve prints would receive five seconds each. The sensitized plate in the camera is thus acted on by a number of images producing one compound image in which the separate characteristics of all have equal representation.

The first composition you are invited to examine is one made from photographs—mainly taken by ourselves last summer—of all the present officers, seventeen in number, of the American Association for the Advancement of Science. In this one head there is an exactly equal representation of the following named:

Profs. Lesley, Cope, Newton, Hilgard, Putnam, Jas. Hall, Langley, Morse, Eaton, N. H. Winchell, Wormley, Gray, Thurston, Jno. Trowbridge, Newcomb, Springer and Eddy.

These notables, all laying their heads together, are supposed to present to our gaze the typical scientific man.

It would extend our interest could we have a sufficient number of specialists to make fair averages in the principal departments of science. Whether these averages would reveal the nice points of difference that would be demanded is a question experience must decide. We shall be happy to press the inquiry.

Next is a series of three composites from seventeen original and cotem poraneous likenesses of Washington, five are three-quarter views, seven are profiles and five are intermediate views of the face. To Mr. Wm. S. Baker, who has furnished an opportunity to make these photographs with a special view to this meeting, we are indebted for the use of these highly valuable portraits, many of which are extremely rare, and would have been otherwise unobtainable.

The last combination is a plunge from Elysium to Hades. Twelve of the criminal class borrowed from the Rogues' Gallery, are melted into one. There is here one murderer The remainder are culprits of ordinary grade, mainly burglars. One is evidently half-witted. It makes only a fair representation to throw in *one* fool.

In considering the *results* of these experiments, I think you will agree that—compared with their respective constituents—the intellectual man is not so intellectual, nor is the villain so villainous. Mr. Galton intimates that this process is a beautifying one. I fear that, just to this extent, one line of its scientific value will be impared ; for, this being the case, we can look for its usefulness only as applied to the most pronounced characteristics.

But if the scientific importance of this process must indeed be limited in one direction, may we not gather from it a useful demonstration of another kind? Does not its rounding and "beautifying" effect,—if you will call it so,—illustrate the idea that the impairment of individuality is the impairment of force? The dream of a "thoroughly balanced man," a "perfectly rounded character," etc., what whould its realization be? Would it be more than a man great in nothing at all? Our scientist, as we see here, is just a "nice looking" man ; but is not all force rounded out of him? The same may be said for our representative from the lower walks of life. All bad men do not look bad the same way, and the overlapping of characteristics tends to destroy characteristics. To borrow from the vagaries of phrenology, fill up between the bumps and there would be no bumps left.

In the case of the Washington heads we are met by no such difficulty. These are the efforts of a number of cotemporaneous artists to present each his own conception of one particular subject, and the historical value of this method of averaging results is beyond computation. It is to portraiture what the sifting of the testimonies of a multitude of eye-witnesses is to the discovery of one set of facts.

Despite the immaturity which must attach to experiments only begun, I trust you may find this presentation of the subject sufficiently suggestive to arouse your own valuable consideration.

CONTRIBUTIONS FROM THE LABORATORY OF THE UNIVERSITY OF PENNSYLVANIA.

No. XXIII.

ON THE VANADATES AND IODYRITE,

From Lake Valley, Sierra Co., New Mexico.

BY F. A. GENTH AND GERHARD VOM RATH.

(*Read before the American Philosophical Society, April 17, 1885.*)

At a meeting of the American Institute of Mining Engineers, held at Washington, D. C., in 1882, the late Prof. Benj. Silliman read a paper "On the Mineral Regions of Southern New Mexico," * in which he gave the first fuller information about the extraordinary occurrence of rich silver ores and the accompanying minerals in the mines of the so-called Sierra Group, comprising the Sierra Grande, Sierra Bella and Sierra Apache.

The geological position had been determined in 1881 by Prof. E. D. Cope, when he showed that the strata in which the ores occur belong to the lower coal measures.

The ores form a bed more or less interrupted, or rather, a series of huge lenticular beds or pockets between the limestone strata, which show a dip of about 30° towards the S. E. This dip flattens to one of only about 15° at a depth of 180 feet. The ore bed is frequently divided by intercalations of limestone strata.

The foot wall consists of a hard, more or less siliceous, blue limestone, with very few fossils, into which the ores frequently penetrate, as if by alteration of the bed rock. The hanging wall is formed by a pale slaty limestone without siliceous inclosures, rich in fossils, but without any ores. The separation between the hanging wall and the ore bed is perfect.

The main body of the ores is formed by oxides of iron and manganese: hematite, limonite, pyrolusite, manganite, psilomelane, and wad, intermixed with variable quantities of cerargyrite and embolite, together with small quantities of native silver and highly argentiferous cerussite and galenite. At many places the upper portion of the ore bed consists of flint and siliceous minerals which cover the argentiferous iron ores, and which are sometimes rich in embolite; pale yellow crystals of vanadinite in druses of quartz are sometimes met with.

These facts, mostly taken from Prof. Silliman's paper, give a brief

* Engineering and Mining Journal, New York, Oct. 14 and 21, 1882, pp. 199 and 206; 212, 213 and 214.

account of the geological position and the accompanying minerals which he had observed.

A few months ago a highly interesting find was made at the Sierra Grande, which furnished some beautiful specimens of very rare species, of which we received a sufficient supply for investigation from Mr. N. H. Muhlenberg, in Lake Valley, and his representative in Reading, Pa., Mr. Theodore A. Kendall, to whom we are greatly indebted for their liberality, also to Mr. Robt. C. Canby, at Pueblo, Col., who has kindly furnished the writer with the vanadinite from the Sierra Bella.

In the following investigation the crystallographic measurements and figures are by Gerhard vom Rath, and the analyses, &c., by F. A Genth.

It may be well to give a general outline of the methods employed for the analyses of the vanadates, described in this paper.

After dissolving in very dilute nitric acid, the insoluble residue was filtered off, then treated again two or three times with dilute nitric acid in order to bring all the vanadates into solution. This was especially necessary in the case of the dark descloizites, but, notwithstanding this, some of the constituents of this mineral remained undissolved, and appreciable quantities of lead, copper and zinc were retained, probably by the manganese dioxide which was present in considerable quantities. These bases were determined and their quantity added to the main portion.

In the filtrate the chlorine was precipitated by a few drops of silver nitrate, the excess of silver removed by just enough hydrogen chloride and the filtrate from the silver chloride evaporated nearly to dryness. A large excess of strong hydrogen sulphide water was then added and the beaker put at a warm place for two days. Lead, copper and arsenic were precipitated as sulphides, but also, invariably more or less zinc,* although the solution was still strongly acid. After two days' standing, the solution had yet a strong odor of hydrogen sulphide. It was filtered off, and the arsenious sulphide separated from the sulphides of lead, copper and zinc, by digestion with sodium hydrate, the filtrate precipitated with hydrogen chloride; the arsenious sulphide, thus obtained, oxydized with strong nitric acid into arsenic acid, which was weighed as pyro-arseniate of magnesium. The precipitate containing lead, copper and part of the zinc as sulphides, was oxydized with strong nitric acid, sulphuric acid was then added and evaporated until the nitric acid was completely expelled. In the filtrate from the lead sulphate the copper was precipitated as sulphide and weighed as oxide, and the zinc converted into sulphide, after neutralization with ammonia, and added to the main portion.

The filtrate from the first hydrogen sulphide precipitate was evaporated and the tetraoxide of vanadium re-converted into vanadic acid by the nitric acid present, whereupon, the solution was boiled with sodium carbonate to separate the zinc, manganese and iron from the *greater* part of the

*In the analysis of descloizite, a2, the zinc was lost, because the filtrate from the lead sulphate which contained a portion of it, was accidentally thrown away.

vanadic and phosphoric acids. As this separation is not complete, the precipitate was fused with sodium carbonate and lixiviated with water, after having reduced the manganic acid by a few drops of alcohol. Iron was separated from zinc and manganese by sodium acetate, the zinc precipitated by hydrogen sulphide from the cold filtrate, after acidulating strongly with acetic acid, and finally the manganese by sodium carbonate. In the united solutions, containing vanadic and phosphoric acids the sodium carbonate was nearly neutralized with acetic acid, and the two acids precipitated either by mercurous nitrate or lead acetate. In the first case the mercury was driven off at the lowest possible temperature, then a little nitric acid was added, the liquid evaporated to dryness, after which the residue, containing pentoxide of vanadium and metaphosphoric acid, was ignited; in the second place, the lead salt was mixed with a little nitric acid, the lead removed as sulphide, the filtrate evaporated and the residue ignited.

It now remained to separate the phosphoric acid from the vanadic pentoxide. They were dissolved in boiling hydrogen chloride, completely reduced by sulphurous acid, and after having added a little tartaric acid and a large excess of ammonia, precipitated with magnesia solution. On account of the minute quantity of phosphoric acid, the liquid was allowed to stand a long time in order to secure a complete precipitation, but, in doing this, a small quantity of the reduced vanadic acid was re-oxydized and contaminated the phosphate with a minute quantity of magnesium-ammonium vanadate. It was necessary, therefore, to re-dissolve in hydrogen chloride, and after addition of a little sulphurous and tartaric acids, to re-precipitate by ammonia, when a perfectly white pyrophosphate of magnesium was obtained.

Vanadinite.

Prof. Silliman was the first to observe vanadinite in pale, yellow hexagonal crystals at the Lake Valley Mines.

a. At the Sierra Bella it is found on wad in thin coatings, consisting of minute crystals of a brownish-yellow color which, under the microscope, show bright hexagonal prisms with the basal plane and the pyramid slightly indicated; powder yellow. Analysis a.

b. At the Sierra Grande several varieties are found.

1. Beautiful crystals, the largest not over 5^{mm} long and 2.5 to 3^{mm} thick; hexagonal prisms, terminated by the basal plane and the pyramid. The angle between the prism and pyramid was found by measurement to be nearly 130°. The planes are often rough, as if corroded by a solvent, and the crystals frequently show cavities, some appear as skeleton-like residues. Smaller crystals of about 1.5 to 2^{mm} in length are perfectly developed and show smooth brilliant faces. The color is orange-yellow, varying from wax-yellow on one side to a deep orange-red, the terminations being generally of the darkest color; cloudy. Powder pale orange-yellow. Lustre greasy, inclining to vitreous. Associated with pyrolusite

and implanted in calcite. Minute very brilliant columbine-red or cherry-red crystals of descloizite are implanted in, or crystallized upon the vanadinite and calcite, and may have been formed from constituents of decomposed or dissolved vanadinite. Analysis b1.

2. Other varieties of vanadinite are associated with the black or dark-brown descloizite. They all show the hexagonal prism and the basal plane, and most of the crystals the pyramid also; a more acute pyramid, and a prism and pyramid of the second order are rarely indicated. The planes are generally smooth and brilliant, but there are some, in which the basal plane is rough, as if corroded, but surrounded by a smooth and brilliant margin. The crystals vary in size from 1.5 to 3^{mm} in length and 0.5 to 2^{mm} in thickness. Their color is from orange-yellow to brownish-orange.

They are mostly of a more recent origin than the brown descloizite which they accompany; it appears, however, that the latter was still growing when this vanadinite and iodyrite were formed, since the large crystals of descloizite are frequently pitted by their impressions; the vanadinite and iodyrite seem to have crystallized simultaneously, but there are smaller crystals of descloizite of a red color of a more recent origin; they are attached to iodyrite, vanadinite and calcite.

Analyses:

a. As not enough of the pure mineral from the Sierra Bella could be obtained, an indefinite quantity of the incrustations upon wad was purified as much as possible by washing off the lighter particles and analyzed. It gave: 0.0153 grm Ag = 0.0050 grm Cl, 0.2261 grm $PbSO_4$, 0.0007 grm $Mg_2As_2O_7$, 0.0021 grm $Mg_2P_2O_7$ and 0.0364 grm V_2O_5.

b1. 1 grm gave: 0.0757 grm Ag = 0.0249 grm Cl, 1.0647 grm $PbSO_4$, and 0.1814 grm $(VP)_2O_5$; 1.5665 grm, after deducting 0.0008 grm quartz or 1.5657 grm pure vanadinite gave: 1.6669 grm $PbSO_4$, 0.0282 grm $Mg_2As_2O_7$, 0.0095 grm $Mg_2P_2O_7$ and 0.2779 grm V_2O_5. These quantities give the following percentage:

	a. Sierra Bella.	Atomic ratio.	b1. Sierra Grande.	Atomic ratio.
Sp. Gr. =	——		6.862	
Cl =	2.39—0.067	= 1	2.49—[2.49]—0.070	= 1
P_2O_5 =	0.57—0.004	} = 0.100 = 1.49	18.14 — 0.39—0.003	} = 0.106 = 1.5
V_2O_5 =	17.37—0.095		—17.74—0.097	
As_2O_5 =	0.24—0.001		not det.— 1.33—0.006	
PbO =	79.43—0.356	= 5.31	78.36—78.31—0.351	= 5
ZnO =	——		—— trace.	
		Less O,	100.26	
		Equiv. to Cl. =	0.55	
			99.71	

The analysis b1 corresponds exactly to the formula $Pb_5Cl\,[(VAsP)O_4]_3$ in which a small portion of the vanadium is replaced by arsenic and phosphorus, while analysis a shows a slight excess of lead which is probably present as cerussite.

Endlichite, or Vanadium-Mimetite, a new species.

In the collection of Mr. Clarence S. Bement was a specimen, labeled vanadinite, which showed such a peculiar appearance that its examination was desirable, for which purpose he has kindly loaned the same.

There are apparently three kinds of crystals present; some of an orange-yellow and orange-red color, probably vanadinite; the largest a little over 1^{mm} in size; they are hexagonal prisms with pyramid and, slightly developed, a second more acute pyramid; both the prismatic and the pyramidal planes are strongly striated through oscillation of the pyramidal planes with the prismatic; then there are one or two bright yellow very minute crystals, which are imperfect and appear as, if made up of several individuals; the planes are the same as those of the orange crystals. The third mineral is developed in the form of very bright straw-yellow crystals, showing the strong striation of the prismatic planes and the two pyramids. On the largest crystals, not over 1^{mm} in length, the basal plane is visible, on the small ones it is quite obliterated. A few of the crystals were hollow.

An imperfect qualitative analysis gave no satifactory results on account of the exceedingly minute quantity at disposal. Fortunately Mr. Muhlenberg succeeded in securing for examination another small specimen which showed some peculiarities, but was evidently the same as Mr. Bement's specimen. Implanted in drusy quartz colored by ferric and manganic oxides, the crystals are yellowish-white or pale straw-yellow, the largest 3^{mm} long and from 0.5 to 1.5^{mm} thick, the forms are those given above. Some of the crystals show only a hollow prism, either empty, or filled with a crystalline powder which now and then assumes hexagonal forms. As the specimen contained only a very minute quantity which could not be picked out, an analysis was made from all the fragments of quartz which showed some of this mineral. On dissolving in dilute nitric acid a slight evolution of carbonic dioxide was observed.

0.9518 grms gave: 0.7276 grm insoluble quartz, etc., 0.0094 grm Fe_2O_3, 0.0029 grm CaO, 0.0127 grm Ag = 0.00417 grm Cl, 0.0277 grm $Mg_2As_2O_7$, 0.0152 grm V_2O_5, and an unweighable trace of $Mg_2P_2O_7$. This gives:

Quartz, &c.,	=	76.44%	
Fe_2O_3	=	0.99	
CaO	=	0.30	
Cl	=	0.44	
As_2O_5	=	2.16	
P_2O_5	=	trace.	
V_2O_5	=	1.60	
PbO	=	15.94	
CO_2, H_2O, &c.	=	2.13	by difference
		100.00	

Deducting the admixtures the pure mineral contains:

					Atomic ratio.
Cl	=	2.18	=	0.061	= 1
As_2O_5	=	10.73	=	0.047 } = 0.090	= 1.48
V_2O_5	=	7.94	=	0.043	
PbO	=	79.15	=	0.355	= 5.82
		100.00			

The small excess of lead is evidently owing to an admixture of cerussite. and the mineral is a combination of one molecule of mimetite with one molecule of vanadinite $= Pb_5Cl[AsO_4]_3 + Pb_5Cl[VO_4]_3$, corresponding to which is the following:

Cl	=	2.44
Pb	=	7.11
As_2O_5	=	11.86
V_2O_5	=	9.60
PbO	=	68.99
		100.00

The name has been suggested by Mr. N. H. Muhlenberg in honor of Dr. F. M. Endlich, Superintendent of the Sierra Mines at Lake Valley, N. M.

Since the above has been written Mr. Muhlenberg sent a new supply of endlichite which was different in appearance from that previously seen. It consisted of groups of crystals of a columnar structure, some radiating from a centre and also forming sheaflike aggregations. In many of them the hexagonal form could be distinctly seen, especially towards the diverging ends which show the basal plane and pyramid very distinctly. They are all strongly striated. The individual crystals are white and yellowish-white or straw-yellow, towards their terminations often changing to yellow and in a few groups to a deep orange red. The largest groups were 10^{mm} in length.

The whitest gave a spec. grav. of 6.864 and contained:

			Atomic ratio.		
Cl	=	2.45	0.069		
PbO	=	73.48	0.330 }	=	0.336
CaO	=	0.34	0.006		
As_2O_5	=	13.52	0.087		
V_2O_5	=	10.98	0.084		
P_2O_5	=	trace			
		100.77			

From this the ratio of the constituents appears to be about the same as

found before, and that arsenic and vanadium are present in the proportion of 1 : 1.

The change of color of these groups of crystals, however, appears to indicate that the vanadiferous mimetite or endlichite may gradually change into vanadinite.

Probably the same mineral has already been observed by Prof. Silliman at the Torrence Mine, Socorro, N. M., where it occurs in small yellow hexagonal prisms which were mistaken for vanadinite, but were mimetite containing vanadium.

Descloizite.

The writer has just received from Prof. Gerhard vom Rath the following communication which he gives in his own words:

"The recently discovered crystals of this rare species surpass in perfec- "tion and development by far those from previously known localities. "They offered an opportunity to examine again the different opinions re- "garding their crystallographic system. (Des Cloizeaux, Ann. de chimie "et de physique, 3 sér, 41,78 and Websky, Zeitsch. für Krystallographie "5,542.)

"If we retain the primitive form suggested by the distinguished French "crystallographer, which has also been adopted by the celebrated Berlin "Professor, changing the system, however, which Des Cloizeaux supposed "to be rhombic, into monoclinic, we have these faces referred to the "rhombic system:

"	o	=	(111),	P.
"	h	=	(132),	$\frac{3}{2}$ P
"	d	=	(012),	$\frac{1}{2}\breve{P}\infty$
"	f	=	(201),	$2\bar{P}\infty$
"	m	=	(110),	∞P
"	l	=	(130),	$\infty\breve{P}3$
"	a	=	(100),	$\infty\bar{P}\infty$
"	b	=	(010),	$\infty\breve{P}\infty$
"	c	=	(001),	o P

"The fundamental angles have been measured as follows:

"	0 : 0′	(brachydiagonal edge)	=	126° 56
"	0 : 0″	(macrodiagonal edge)	=	90 54

'thence the proportion of the orthogonal axes:

' $\breve{a} : \bar{b} : \dot{c} = 0.6367 : 1 : 0.8046.$

		Calculated.		Measured.
"	o : o (lateral edge)	=	112° 32½′	
"	h : h (brachydiagonal edge)	=	88 51½	
"	h : h (macrodiagonal edge)	=	136 6	
"	h : h (lateral edge)	=	107 26	
"	m : m (over a)	=	115 ½	
"	l : l (over a)	=	55 16	
"	o : m	=	146 16¼	146° 22′
"	h : l	=	143 43	
"	d : d (over c)	=	136 10½	136 {4, 14
"	f : f (over a)	=	136 49⅓	
"	m : l	=	150 7¼	
"	d : o	=	133 ¼	133 12
"	f : o	=	148 56⅓	

"The pyramid h has, however, such minute faces, that accurate meas- "urements were impossible.

"With great attention I treated the question whether our mineral be "rhombic or monoclinic, having at my disposal a good crystal allowing "measurements on one side as well as on the other side of the axis a "(brachydiagonal). I found:

"	o : o (in front)	=	126° 52′
"			126 53
"	o · o (behind)	=	126 55
"			126 56

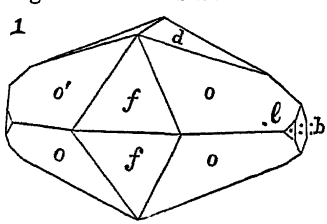
"Considering the development of the faces, this difference does not exceed "the probable error. Besides, not having observed any indication of "twinning, I thought it necessary to maintain the rhombic system, adopt- "ing Des Cloizeaux's opinion. Supposing Websky's views to be correct, "the calculation of the two mentioned angles would give the following "results:

"	o : o (in front)	=	126° 43′
"	o : o (behind)	=	126 16

"a difference which cannot exist in our crystals.

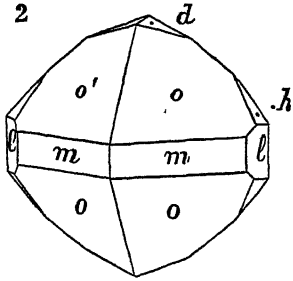
"The development of the New Mexican descloizites is different, as our "figures 1–4 will show:

1



"Fig. 1 represents crystals of a dark "red color (implanted), attached on a "quartzitic gangue which is covered "with psilomelane. The crystals reach "2^mm in size and are very bright. A "specimen of this kind was used for "the measurements. The faces f are "striated and dull.

2

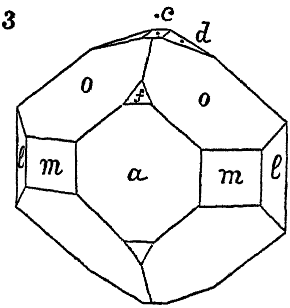


"Fig. 2. The crystals reach 1^{mm} in size, "they are highly aggregated, sometimes so "thickly and in such subparallel position "that the faces seem to be broken. The "best specimen of this kind gave the fol- "lowing results:

" o : o (brachydiagonal edge) = 126° 45′
" o : m = 146 24

"Considering the minuteness of these crys- "tals and the fact that the reflection is not "sharply defined, this agreement can be "regarded as sufficient. They are attached "to a quartzitic gangue and of columbine "red color.

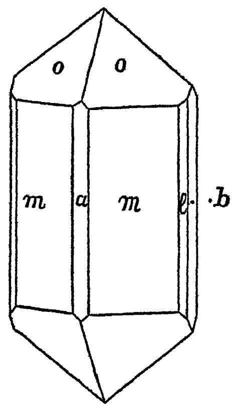
3



"Fig. 3 shows crystals of larger size, "reaching 8^{mm}. The faces are somewhat "uneven, blackish-red, opaque; the plane "a striated by oscillation with f.

"Fig. 4. Wonderfully fine crystals with "the dominant prism m. Their size reach- "es 3^{mm}. Implanted on a quartzitic gan- "gue with pyrolusite.

4



"There is a distinct cleavage parallel to "face b, producing a reflection from the in- "terior of the crystals in this direction.

"Regarding the optical properties of des- "cloizite I take pleasure in communicating "the following lines from a letter of M. Des "Cloizeaux, dated March 18th, 1885:

"'Les anciens petits cristaux de Córdoba, "portant presque toujours la base, m'avaient "fourni plusieurs lames minces bien paral- "lèles à cette face et qui paraissaient per- "pendiculaires à la bissectrice *negative*, avec "plan des axes parallèle à la petite diagonale. "Mais les axes sont si écartées autour de "cette bissectrice et la dimension des lames "si exiguë qu'il ne m'a jamais été possible "d'apercevoir les anneaux dans l'huile. A travers les lames h^1, perpendic- "ulaires aux premières, mais d'une orientation nécessairement moins cer- "taine il est également impossible de voir les anneaux autour la bissectrice "*positive*. On peut donc *seulement dire* que les bissectrices *paraissent* avoir "l'orientation qu'elles auraient dans un prisme rhombique, mais il manque, "pour avoir une certitude *presque absolue* la constatation de l'absence ou "de l'existence d'une dispersion inclinée. Quant aux nouveaux cristaux

"j'ai fait un éssai préliminaire et le hasard m'a fait détacher un angle d'un "petit cristal passablement translucide. Il portait 2 faces m et 2 faces "o($b\frac{1}{2}$). De la patience, un peu d'adresse et beaucoup de bonheur m'ont "permis d'arriver à une lame très sensiblement parallèle aux 2 arêtes "m : o, et passablement transparente, lorsqu'elle a été très amincie. La "masse est peu homogène comme dans les lames extraites des cristaux de "Córdoba et une bande noir opaque la traverse en son milieu. Il n'y a "donc rien d'étonnant à ce que les analyses faites jusqu'ici offrent des "différences dans les proportions de zinc, de manganèse ou de cuivre. "Plan des axes parallèle á la petite diagonale et bissectrice *negative* normale "à la lame et par conséquant parallèle à l'axe verticale ; malheureusement "les côtés du triangle (de la lame) n'ont guère que $\frac{3}{4}^{mm}$, mais il y a bien "d'espérer que quand on pourra sacrifier sans regret un ou deux gros "cristaux pour les réduire en plaques excessiment minces, on arrivera à "voir les anneaux dans l'huile, et par suite à s'assurer quel genre de dis- "persion ils présentent.'".

From the foregoing it has been observed that the descloizite of the Sierra Grande occurs in several varieties. In the first place there are :

a. Minute crystals from microscopic to about 1^{mm} in size, often sharply defined, varying in color, rarely orange-yellow, mostly from columbine-red to cherry-red and reddish-brown to pale clove-brown. Powder pale orange-yellow with a slight brownish tint. The crystals are isolated, but generally united in groups, sometimes forming incrustations, and are associated with calcite, quartz, iodyrite, vanadinite, pyrolusite and psilomelane, sometimes completely incrusted by the latter. Decrepitates on ignition and fuses to a grayish-black mass. This variety is represented by Fig. 2, and its composition is given in analysis a, 1, 2 and 3.

b. The other variety, Fig. 3 and 4, is found in larger crystals, some of which reach 8^{mm} in size. They are brownish-black or black, either opaque or, in transmitted light, of a reddish-brown color. Powder blackish-gray with a yellow tint. Decrepitates on ignition and fuses to a black slag.

As a rule, these crystals are very impure, being frequently penetrated by a large admixture of pyrolusite which, on dissolving in dilute nitric acid, remains behind.

These dark crystals appear to be the oldest of the vanadates, found at Lake Valley. They crystallize upon quartz and are associated with vanadinite, iodyrite, descloizite of a more recent origin, pyrolusite, psilomelane and calcite.

Analyses :

a. *Red crystals.*

a1. For a preliminary analysis 0.4769 grm red crystals, slightly coated with pyrolusite, was used. They gave 0.0630 grm pyrolusite and quartz which, deducted from the above, left 0.4139 grm pure descloizite which gave : 0.3140 grm $PbSO_4$, 0.0048 grm CuO, 0.0704 grm ZnO, 0.0082 grm Mn_3O_4 and 0.0873 grm V_2O_5.

a2. 1.1043 grm of nearly pure brownish-red crystals gave 0.0135 grm pyrolusite and quartz. giving 1.0682 grm pure vanadates, which gave 0.0017 grm Ag = 0.0006 grm Cl or 0.0226 grm vanadinite, which amount being deducted gave 1.0682 grm descloizite, furnishing 0.8396 grm $PbSO_4$. less 0.0239 grm for vanadinite or 0.8157 grm., 0.0098 grm CuO, 0.0043 grm Mn_3O_4, 0.0012 grm Fe_2O_3, 0.2454 grm V_2O_5, less 0.0044 for vanadinite or 0.2410 grm, no P_2O_5 and 0.0036 grm $Mg_2As_2O_7$. The zinc was lost.

a3. 0.9762 grm of the red crystals, which were freed with the greatest care from all vanadinite, gave 0.0060 grm quartz or 0.9702 grm pure material which gave: 0.0230 grm loss on ignition, 0.7426 grm $PbSO_4$, 0.0121 grm CuO, 0.1727 grm ZnO, 0.0064 grm Mn_3O_4, 0.0040 grm Fe_2O_3, 0.0022 grm $Mg_2As_2O_7$ and no P_2O_5. The V_2O_5 was determined by difference.

In the average of the three analyses the percentage of MnO in a1 is left out, because it is evidently too high.

	a1	a2	a3	Mean.	Atomic ratio.	
Sp. Grav.=	——	6.108	6.105	——		
PbO =	55.83	56.20	56.33	56.12	= 0.251	= 2.09
CuO =	1.16	0 90	1.24	1.10	= 0.014	
ZnO =	17.02	lost	17 80	17.41	= 0.215	
MnO =	1.84	0.37	0.61	0.49	= 0.007	= 0.238 = 1.98
FeO =	not det.	0.10	0.19	0.15	= 0.002	
As_2O_5 =	"	0.24	0.17	0.20	= 0.001	= 0.120 = 1.
V_2O_5 =	21.09	22.56	21.29	21.65	= 0.119	
H_2O =	not det.	not det.	2.37	2.37	= 0.136	= 1.13
			100.00	99.49		

c. *Blackish-brown crystals.*

c1. This analysis was made with the residue from which the best material was selected for c2 and c3, especially with reference to the amount of water present and the admixture of pyrolusite. 1.1004 grm gave on ignition a loss of 0.0290 grm. The residue, containing 0.0288 grm quartz, gave 0.0040 grm Fe_2O_3 and 0.0829 grm MnO_2 which were deducted as impurities. In the analysis c2 the chlorine was determined which represents the vanadinite, and from this the corresponding quantities were calculated for c1 and c3. 0.9847 grm, free from SiO_2, MnO_2 and Fe_2O_3 would contain 0.0402 grm vanadinite or 0.9445 grm descloizite which gave: 0.7579 grm $PbSO_4$ less 0.0427 grm for vanadinite or 0.7152 grm, 0.0081 grm CuO, 0.1318 grm ZnO, 0.0326 grm Mn_3O_4, 0.0029 grm Fe_2O_3, 0.0068 grm $Mg_2As_2O_7$, a trace of P_2O_5 and 0.2052 grm, less 0.0079 grm for vanadinite or 0.1973 grm V_2O_5.

c2. 1.1300 grm of the purest crystals gave: 0.0720 grm MnO_2, 0.0015 grm Fe_2O_3 and 0.0032 grm quartz, giving for the vanadates 1.0533 grm, less 0.0442 grm vanadinite or 1.0091 grm descloizite, which gave: 0.8221 grm $PbSO_4$, less 0.0470 grm for vanadinite, or 0.7751 grm, 0.0106 grm CuO,

0.1469 grm ZnO, 0.0301 grm Mn_3O_4, 0.0038 grm Fe_2O_3, 0.2269 grm V_2O_5 less 0.0086 grm for vanadinite, and 0.0033 grm Ag = 0.0011 grm Cl = 0.0442 grm vanadinite. P_2O_5 and As_2O_5, on account of their small quantity, were determined from the material of c2 and c3 and, after the deduction of the foreign substances, 2.0498 grm descloizite gave 0.0131 grm $Mg_2As_2O_7$ and 0.0015 grm $Mg_2P_2O_7$.

c3. Another portion of the same crystals was ignited strongly in a platinum crucible. 1.1560 grm gave a loss of 0.0518 grm. The mineral was fused to a black slag and the crucible badly injured. The fused mass was dissolved with difficuly in dilute nitric acid and gave 0.0018 grm SiO_2, but contained no higher oxides of manganese. Taking the analysis cb as the basis for the subtraction of the impurities 0.0736 grm is obtained for MnO_2 and 0.0039 grm for Fe_2O_3, giving for the vanadates 1.0767 grm less 0.0450 grm vanadinite or 1.0317 grm descloizite. 0.0736 grm pyrolusite has lost by strong ignition 0.0135 grm oxygen which, subtracted from 0.0518 grm loss by ignition, leaves 0.0383 grm for water. The analysis gave: 0.8444 grm $PbSO_4$, less 0.0478 grm for vanadinite or 0.7966 grm, 0.0074 grm CuO, 0.1365 grm ZnO, 0.0241 grm Mn_3O_4, 0.0034 grm Fe_2O_3 and 0.2312, less 0.0092 grm for vanadinite or 0.2220 grm V_2O_5.

The analyses of the blackish-brown descloizite gave, therefore, as follows:

	c1	c2	c3	Mean.	Atomic ratio.		
Sp. Grav. =	——	5.882	5.814	——		——	
PbO =	55.73	56.53	56.82	56.36	= 0.252		= 2.12
CuO =	0.85	1.05	0.70	0.87	= 0.011	= 0.226	= 1.90
ZnO =	13.95	14.56	13.23	13.91	= 0.172		
MnO =	3.21	2.77	2.23	2.74	= 0.039		
FeO =	0.27	0.34	0.30	0.30	= 0.004		
As_2O_5 =	0.53	0.48	0.48	0.50	= 0.002	= 0.119	= 1.
P_2O_5 =	trace	0.04	0.04	0.04	= ——		
V_2O_5 =	20.89	21.63	21.52	21.35	= 0.117		
H_2O =	3.07	not det.	3.71	3.39	= 0.189		= 1.59
	98.50		99.03	99.46			

The analyses of the dark descloizites, after the subtraction of their admixtures gave approximations, agreeing very closely with the analyses of the best and purest red varieties. Both contain equal atoms of lead and zinc, the latter, in part, replaced by the isomorphous metals manganese, iron, and copper, the dark varieties containing a smaller quantity of zinc and a correspondingly higher of manganese. A very small quantity of the vanadium is substituted by arsenic and phosphorus. In the red crystals the hydrogen is about in the same ratio as vanadium, while the dark varieties contain more of the former, but as there is an uncertainty whether some of the evident admixtures do not contain water, not too much importance

should be attached to this higher percentage. The formula for descloizite corresponds to those of adamite, libethenite and olivenite, being:

$$Pb_2[HO](VAsP)O_4 \quad + \quad Zn_2[HO](VAsP)O_4.$$

Iodyrite.

Frequently associated with the vanadates of the Sierre Grande, and implanted in calcite in straw yellow to bright sulphur-yellow imperfect crystals and crystalline masses. The best specimen which could be obtained was sent by the writer to Prof. G. vom Rath, who describes them as follows: "The crystals of iodyrite (yellow) are imperfect in "their formation, nevertheless they allow one to determine their form as "a combination of the hexagonal prism and the basal plane. The des- "cloizite shows large brown crystals of 4^{mm} in size and of older origin, "and smaller ones of light red color and of later origin, attached to the "iodyrite and calcite."

The spec. grav. of this variety was found to be 5.609, but the analysis was unfortunately lost, it was found qualitatively, however, that it was pure iodide of silver.

Another variety which is generally associated with the dark variety of descloizite and frequently implanted in it and leaving impressions on its planes, forms minute rounded crystals, rarely 1^{mm} in size, and shows sometimes little hexagonal prisms with basal plane; their color is mostly very pale greenish-yellow, seldom brighter. A qualitative test gave also pure iodide of silver.

University of Pennsylvania, April 16th, 1885.

The Chase–Maxwell Ratio. By Pliny Earle Chase, LL.D.

(Read before the American Philosophical Society, April 17, 1885.)

In 1872 (*Proc. Amer. Phil. Soc.*, xii, 394), Chase showed that the tendency of particles, in exploded gases, toward primary and secondary centres of oscillation, leads to a permanent *vis viva* of equilibrium which is $\frac{5}{9}$ of the *vis viva* of explosive projection, and that the synchronous action of the sun and the earth upon the oscillating particles furnishes a ready method for estimating the sun's mass and distance. He also showed (*Ibid*, p. 403–5), that the successive planetary positions in the solar system illustrate the influence of æthereal oscillations of a similar character. In 1875 he showed (*op. cit.*, xiv, 651), that the mean velocity of expanding gaseous pressure is $\frac{2}{\pi}$ of the corresponding constant velocity

of revolution ; the ratio of *vis viva* is, therefore, $\frac{4}{\pi^2} = .405285$, and we have $K : k :: 1.405285 : 1$.

In 1877, Preston (*P. Mag.*, iii, 453 ; iv. 209), showed "that a physical relation exists between the velocity of the particles of a medium constituted according to the kinetic theory, and the velocity of propagation of a wave in the medium." Maxwell calculated the numerical value of this relation at $\sqrt{\frac{5}{9}}$, which represents Chase's ratio of relative *vis viva;* but he did not give the method by which he reached that result, and no record of it was found among his papers. The following thermodynamic demonstration may, therefore, be satisfactory to those who have found any difficulty in accepting the more simple and more general photodynamic proof, which is furnished by reference to oscillatory centres.

If we represent the density of a gas, $\frac{nm}{v}$, by ρ, the fundamental equation of pressure becomes

$$p_\mu = \frac{\rho c^2}{3} = \frac{p_0}{3} \quad \text{(1)}$$

Alexander Naumann, (*Ann. Pharm.*, 1867, 142, 267 ; *J. B.*, 1867, 62) showed that

$$\mu = \frac{3}{2}(\gamma' - \gamma) \quad \text{(2)}$$

μ being the heat of molecular motion, or mean *vis viva* of a perfect gas ; γ', the specific heat under constant pressure ; γ, the specific heat under constant volume ; $\gamma' - \gamma$, the heat of expansion, or *vis viva* of mean velocity. The total specific heat is, therefore,

$$\theta = \mu + \gamma' - \gamma = \frac{5}{3}\mu \quad \text{(3)}$$

$$\text{Hence, } p_\theta : p_0 :: 5 : 9 \quad \text{(4)}$$

$$v_\theta : v_0 :: \sqrt{5} : 3 \quad \text{(5)}$$

Prof. d'Auria, in a special investigation relating to the dynamics of direct-acting pumping engines, not yet published, has found, by analogy, that

$$\mu = \frac{6\gamma}{\pi^2} = .607927\gamma \quad \text{(6)}$$

Substituting this value in eq. (2) we get Chase's result :

$$\gamma' - \gamma = .405285\gamma \quad \text{(7)}$$

$$\gamma' = 1.405285\gamma \quad \text{(8)}$$

The exactness of agreement between this *a priori* value and the one which was found by Röntgen (1.4053 ; *Pogg*, 1873, 148, 603), is very remarkable.

Thermo-electro-photo-baric Unit. By Pliny Earle Chase, LL.D.

(Read before the American Philosophical Society, April 17, 1885.)

The earliest attempt at measurement, with a view to demonstrate the correlation of thermal and electric energies, appears to have been that of Principal Forbes, who found, in 1832 (*P. Mag.*, iv, 27), that the conductivity of metals for heat and electricity, is nearly the same. The dimensions of absolute measure involved were *M, L.*

In 1843, Joule published his discussion of the calorific effects of magneto-electricity, and his determination of the mechanical equivalent of heat (*P. Mag.*, xxiii, 263, 347, 435), using the same dimensions, *M, L.*

In 1856, Weber extended the correlation of Forbes (*Pogg. Ann.*, xcix), by showing the approximate equality of the electro-magnetic ratio to the velocity of light ($L\ T^{-1}$).

Wolf's discovery of the sun-spot period was followed, in 1857, by the investigations of Lamont and Sabine, showing the identity of the sun-spot periods with the periods of magnetic perturbation (*Mag. and Meteorol. Obs., Toronto,* III, lxviii; *St. Helena,* II, cxxi–cxxxvi).

In 1860, Henshall showed the influence upon sun-spots which is produced by Mercury, Venus and Jupiter, when in conjunction with the same face of the Sun (*Cosmos*, xvii, 573).

In 1863, Chase showed (*Proc. Amer. Phil. Soc.*, ix, 283–8; *P. Mag.*, xxviii, 55–9) that the mass of the Sun can be approximately estimated from the influence upon the barometer of the constrained "relative motions" of the Earth and Sun. In 1864, he showed, by the investigation which received the Magellanic medal (*Trans. Amer. Phil. Soc.*, xiii, 117–36; *Proc. Amer. Phil. Soc.*, ix, 425–40; *P. Mag.*, xxx, 52–7), that the magnetic disturbances of the Sun and Moon are many times greater than simple tidal disturbances, and that they can be very closely represented by the disturbances of gravitating pressure, under constrained and "coercitive" relative motion. In 1869, he further showed (*Proc. Amer. Phil. Soc.*, xi, 103–7), that the constrained relative motion at Sun's surface represents a cyclical gravitating and electric disturbance which acts with the velocity of light.

In 1873, Maxwell (*Electricity and Magnetism*), published his theory that light consists of a disturbance in a medium susceptible of dielectric polarization.

In 1884, Langley (*Researches on Solar Heat*), confirmed the identity of thermal, electric, and luminous radiation, for which Chase had suggested probable reasons in 1864 (*Proc. Am. Ph. Soc.*, ix, 408), and Draper in 1872 (*P. Mag.*, xlvi, 104–17).

All of the foregoing investigations can be coördinated, in the region of greatest known energy, by means of the kinetic unit $\frac{\mu v_0^2}{2}$, in which μ represents an infinitesimal particle, and v_0 is the velocity of light, the elec-

tric ratio, the projectile velocity which represents thermo-dynamic energy at Sun's surface, and the projectile velocity which represents the maximum energy both of constrained rotation and of free revolution in the solar system.

The greatest constant energy of free revolution, which can be given to μ by solar attraction, is $\frac{\mu v_k^2}{2}$, v_k being the velocity of circular orbital revolution at the Kantian radius r_k, where solar rotation and orbital revolution are synchronous. The same energy would give synchronous radial or elliptic revolution through or about a major axis $2r_k$, under gravitating acceleration varying inversely as r^2.

The energy which would be required to produce synchronous radial oscillation, under the constant gravitating acceleration, g_k, would be π^2 times as great, or $\frac{\mu\pi^2 v_k^2}{2}$.

The energy which would be required to produce constant radial oscillation in the region of maximum solar gravitation and coercitive force (at Sun's surface) would be k^4 times as great, or $\frac{\mu\pi^2 k^4 v_k^2}{2} = \frac{\mu\, v_o^2}{2}$, k being the ratio of the Kantian radius to the solar radius.

The time which would be required to communicate this maximum energy is t_k, the time of virtual projection against uniform resistance, in the region of greatest solar energy, which is also the time of solar half rotation, as well as the minimum time of synchronous elliptic, circular and radial oscillation in the solar system.

The ordinary thermal and gravitating units may be deduced from the general unit by means of the equations

$$g_n = \frac{m_n\, r_o^2\, v_o}{m_o\, r_n^2\, t_k}$$

$$T = \frac{v_o^2}{2 g_3\, h}$$

In the second of these equations T represents the mass of water which could be heated one degree by μ of oscillating luminiferous æther, or the number of degrees to which μ of water could be heated; g_3, gravitating acceleration at Earth's equator; h, the linear dimension of the mechanical unit of heat.

The harmonic values are as follows:

$m_o = 329414\ m_3$

$r_o = 108.923\ r_3$

$g_o = 27.765\ g_3$

$v_o = 185500$ miles per second.

$g_3 = 32.033$ feet per second.

$T = 10{,}775{,}492{,}000{,}000°C.$

A contribution to the Herpetology of Mexico. *By E. D. Cope.*

(*Read before the American Philosophical Society, April 17, 1885.*)

I. THE COLLECTION OF THE COMISION CIENTIFICA.

This collection has been on exhibition in the department of Mexico in the World's Exposition at New Orleans the present winter. Through the courtesy of the Commision, and especially of Dr. Fernando Ferrari Perez, the Director, I had the opportunity of making an examination of it. The following catalogue is valuable on account of the precision with which the localities can be fixed, which is a point of first importance in the zoōlogy of Mexico. The collection was made in the States of Vera Cruz and Puebla, and the localities mentioned are all in the Tierra Templada.

BATRACHIA.

SPELERPES BELLII Gray. Jalapa, Vera Cruz.

BUFO INTERMEDIUS Gthr. Yzucar de Matamoros, Puebla.

BUFO AGUA Daud. From the belly of a *Sibon annulatum.*

HYLA NIGROPUNCTATA Boul. Teziutlan, Puebla.

HYLA GRACILIPES Cope, Puebla. Said to be very abundant near the city of Puebla. I have led Dr. Boulenger (Catalogue British Museum) into error with regard to this species by accidentally inverting the relative sizes of the eye and tympanic disc in describing them. The disc is one-half the diameter of the eye, and not the reverse. In the Puebla specimens the posterior digits are a little shorter than in the type.

SMILISCA BAUDINI D. and B. Jicaltepec, Vera Cruz.

LITHODYTES RHODOPIS Cope. Puebla.

LACERTILIA.

ANOLIS ? SALLÆI Gthr. Jicaltepec.

PHRYNOSOMA ORBICULARE Wiegm. Teziutlan.

UTA BICARINATA Dum. Yzucar de Matamoros.

This locality greatly extends the range of this species, which has hitherto only been known from the West Coast and the Plateau.

SCELOPORUS MICROLEPIDOTUS Wiegm. Teziutlan.

SCELOPORUS ÆNEUS Wiegm. Yzucar de Matamoros.

SCELOPORUS SPINOSUS Wiegm. Tlapanala Puebla.

SCELOPORUS VARIABILIS Wiegm. Jicaltepec ; Matamoros.

SCELOPORUS GRACIOSUS B. &. G. var. Jalapa ; Matamoros.

CYCLURA PECTINATA Wiegm. Tlapanula.

CYCLURA ACANTHURA Wiegm. Tlapanula.

CHAMÆLEOPSIS MEXICANUS Wiegm. Misantla, Vera Cruz.

LÆMANCTUS SERRATUS Cope. Jicaltepec.

CNEMIDOPHORUS SEXLINEATUS L. Matamoros.

CNEMIDOPHORUS COMMUNIS Cope. Matamoros.

CNEMIDOPHORIS UNDULATUS Wiegm. Jicaltepec.

GERRHONOTUS LIOCEPHALUS Wiegm. Teziutlan.

BARISSIA IMBRICATA Wiegm. ? Loc.

EUMECES FURCIROSTRIS Cope. Jalapa.

ANELYTROPSIS PAPILLOSUS Cope, gen. et sp. nov. Anelytropidarum.

The present form is essentially interesting as introducing for the first time to the Western continent, the family of the Anelytropidæ, or the Typhlophthalm lizards with the eye entirely concealed, and with the tongue scaly. The importance of this discovery is considerable, as it shows that the scincoid lizards have undergone in the New World the same degenerative process as in the Old World, and in the same way. This is a new fact, even supposing that the Aniellidæ of America are a degenerate form of the same family, which is not probable. Dr. Boulenger believes* that that family is a degenerate type of the Anguid stem ; a view in which I suspect he is correct. Anelytropsis is a degree further down in the scale than Aniella, in having the epidermis absolutely continuous over the eye, as in other members of the family of Anelytropidæ, and as in the Typhlopid family of snakes. As in other forms of this character, the life of this type is doubtless subterranean, which accounts for its having so long escaped observation.

Pending the time when I shall be able to make an osteological study of this genus, I give its external characters, as follows :

Char. gen. Rostral plate capping muzzle, the nostril at the junction of its posterior border with the suture separating the loreal and first labial. No frontonasal nor supraorbital plates. Three plates on top of head, which should probably be identified as anterior and posterior frontal and pariëtal. Eye scarcely visible through the single ocular plate. Scales equal, smooth. Vent not terminal. No limbs. No preanal pores.

This genus only differs from Feylinia Gray (= Anelytrops Hallow), in the arrangement of the lateral plates of the muzzle. In that genus and Typhlosaurus, the only other genus of the family, the rostral plate is as in Acontias ; *i. e.*, divided longitudinally on each side by a fissure which extends from the nostril posteriorly. Whether the internal characters differ remains to be ascertained †. I give the genus the name Anelytropsis in order to justify the family name Anelytropidæ. This will produce no confusion, as the name Anelytrops was given by Hallowell to the genus which had previously been named Feylinia, and as a synonym disappears from view.

* Annals and Magazine of Natural History, 1885, p. 121.

† I have given the skeletal characters of Feylinia and Typhlosaurus, Proceeds. Acad. Philadelphia, 1864, p. 224.

Char. Specif. Form slender. Tail moderately long, with obtuse extremity. Scales scincoid, with rounded edges, everywhere equal, including the preanal region. Color brownish flesh-color.

The head is distinguishable from the body by its slightly greater width, and is slightly contracted at the position of the orbits, and continued as a distinct muzzle. The body is cylindrical, and the tail is a little longer than one-fourth the total length. Twenty longitudinal series of scales. The area represented by the rostral plate of Acontias, is invaded on each side by two labial plates, and a large loreal above them. Behind the second labial plate is a very small third, and above it is a large ocular plate which extends upwards and forwards to a line with the superior border of the loreal. The pale spot which represents the eye is situated in the lower posterior corner. The fourth and last labial is a little larger than the second, and has a narrowly rounded posterior extremity. Above it is a small postocular, which is in contact with the posterior frontal. On the summit of the head there are three scuta. The anterior, or anterior frontal is the smallest. It forms a transverse band between the loreal and ocular of one side and those of the other. The succeeding plate, the postfrontal, is the largest. It is succeeded by the pariëtal, which is a transverse plate, concave in front and convex posteriorly, and which is separated from the postocular on each side by a single scale. Posterior to this scute, the scales of the body commence.

There is a large symphyseal plate which is a triangle with its apex posterior and truncate. It is bounded on each side by a very large inferior labial, which is also a triangle. This is followed on the labial margin by two very small labial plates. A small body scale succeeds the symphyseal, and this is connected with the small posterior labials by a narrow plate on each side. These are followed by the body scales. Six laterally imbricated scales bound the vent in front.

Total length, M. .170; length of tail, .045; of head, to line connecting rictioris, .0041.

The rostral, loreal and anterior two labial scuta are marked with minute papillæ, which when removed leave punctiform impressions. They are not very closely placed. From near Jalapa.

Ophidia.

Rhabdosoma semidoliatum D. & B. Misantla.

Adelphicus quadrivirgatus Jan. Jicaltepec.

As Dr. J. G. Fischer remarks, Rhegnops Cope is identical with Adelphicus Jan.

Tantilla calamarina Cope. Teziutlan.

Henicognathus, sp. Jicaltepec.

Rhadinæa proterops Cope. Teziutlan.

Rhadinæa decorata Gthr. Jicaltepec.

RHADINÆA IMPERIALIS B. & G. Jicaltepec.

OPHIBOLUS POLYZONUS Cope. Jicaltepec.

PLIOCERCUS ELAPOIDES Cope. Teziutlan.

NINIA ATRATA Hallow. var. SEBÆ D. & B. Jicaltepec.

NINIA DIADEMATA B. & G. Jalapa.

STORERIA DEKAYI Holbr. Jicaltepec.

EUTÆNIA ORNATA B. & G. Jalapa.

EUTÆNIA SCALARIS Cope. Teziutlan.

EUTÆNIA PULCHRILATUS Cope.

TROPIDONOTUS RHOMBIFER Hallow. Misantla.

SPILOTES CORAIS L. var. EREBENNUS Cope.

DRYMOBIUS MARGARITIFERUS Schl. Misantla.

HAPSIDOPHRYS MEXICANUS D. & B. Jicaltepec.

LEPTOGNATHUS NEBULATUS L. Jicaltepec.

LEPTOGNATHUS FASCIATA Günth. Jicaltepec.

TRIMORPHODON ? COLLARIS Cope. Matamoros.

SIBON ANNULATUM L. Teziutlan ; Jicaltepec.

ELAPS APIATUS Jan. Jicaltepec.

BOTHROPS ATROX L. Jicaltepec.

CROTALOPHORUS RAVUS Cope. An adult specimen which differs from the type in bearing only twenty-one rows of scales. The dorsal spots are much longer than wide, covering five rows of scales each way.

CROTALUS TRISERIATUS Wagl. Teziutlan.

CROTALUS BASILISCUS Cope.

BOA MEXICANA Jan. Jicaltepec.

STENOSTOMA sp.

II. ZACUALTIPAN, HIDALGO.

The small collection enumerated below was made partly by myself and partly by my friend, Dr. Santiago Bernad, in the neighborhood of the town of Zacualtipan in the north-eastern part of the State of Hidalgo, close to the boundary line of the State of Vera Cruz. The region is elevated, and belongs to the warmer part of the Tierra fria, but the ravines which intersect the country in many places, have the characters of the Tierra templada, and at a short distance from the town merge into the Tierra caliente. The higher lands are covered with brake, *Pteris aquilina,* and plants of the genera Andromeda or Vaccinium or both ; or are covered with forests of pine or of fir. Deciduous trees are of the genera Alnus, Negundo, Liquidambar, Platanus, etc., and wild species of Rubus and Potentilla abound. The *Taraxacum densleonis* is common, but whether introduced or not, I do not know. Introduced species of Vinca and Rosa grow lux-

uriantly. On the sides of the ravines where moist, Zamias and short tree-ferns, with other tropical plants, abound, and in their bottoms, innumerable Cactaceæ, Agaves and Tillandsiæ are growing in a state of nature; and oranges, bananas, Erythrinas, are cultivated. The reptiles of the following catalogue were nearly all taken on the high country, the only exception I know of being the Syrrhophus, which came from the bottom of a ravine about two thousand feet below the general level.

BATRACHIA.

SYRRHOPHUS VERRUCIPES, sp. nov.

Posterior limbs of moderate length, the heel reaching to the anterior edge of the eye. The toes of moderate length, with small pallettes, but the anterior a little larger, and with prominent warts below, which are especially large at the ends of the metapodial bones. One large palmar, and two small solar tubercles. Skin everywhere smooth except on the sides, which are tubercular-areolate. No abdominal or gular fold. Head flat above, moderately wide, with muzzle slightly prominent, vertical loreal region, and obtuse canthus rostralis. Tympanic membrane more than two-thirds diameter of eye-slit. External nares almost at extremity of muzzle; internal nares larger, and so widely separated as to be partially lateral in position.

Color above dark bluish gray, marked with numerous black spots with ill-defined borders. Limbs similar, with black cross-bands, which continue on the external digit of each foot. Upper surface of femur, with close white spots on a dark ground; posterior face dark, with a few small white spots. Edge of lip with a few light spots. Inferior surface white, unspotted.

Length of head and body, .026; of head to line connecting ricti oris, .008; length of fore limb, .018; of posterior limb, .039; of posterior foot, .018; of tarsus, .008; width of head behind, .009.

This species is well marked by its proportions and its color. Its legs are longer and the tympanum is larger than in the *S. marnochii* of Texas, which it slightly resembles in color. I found it in the bottom of a rocky gorge of a stream near its junction with the San Miguel river, at a depth of at least 1800 feet below the level of the town of Zacualtipan.

The *Phyllobates bicolor*, type of that genus, has narrow lateral nasal bones, as in Elosia. In *Syrrhophus* they are as in Hylodes. The Phyllobates with areolated bellies, form, I think, a separate genus, for which I propose the name Hypodictyon; type *H. ridens* (*Phyllobates ridens* Cope). Other species are *H. verruculatus* and *H. chalceus* of Peters.

There is a tree-frog, hitherto referred to *Hyla*, which is peculiar in having the glandular areolation, which is confined to the belly in all other species, extended over the dorsal region as well. This is the *Hyla gratiosa* of Leconte of Florida and Georgia. On this account I propose to refer this to a new genus under the name of Epedaphus.

Hyla miotympanum Cope. This species was in the water at the time of my visit (March). In daylight its color is bright green.

Rana halecina Kalm.

Lacertilia.

Sceloporus microlepidotus Wiegm.

Barissia imbricata Wiegm.

Oligosoma gemmingeri Cope. Indian name, Cholumpipi.

Ophidia.

Rhabdosoma mutitorques, sp. nov.

Scales all smooth, in seventeen longitudinal series. One postocular; inferior labial of first pair in contact in front of pregeneials, which are twice as long as postgeneials. Internasals one-fourth size of prefrontals. Frontal wider than long, anterior border gently convex. Parietals as long as prefrontal and frontal together. Rostral plate not visible from above. Superior labials six, all higher than long, except fifth, which is as high as long, and the sixth, which is longer than high. The fifth is separated by one, and the sixth by two temporals from the parietal. The eye and the superciliary plate are quite small. Seven inferior labials, fourth largest and in contact with postgeneials. Gastrosteges 172; anal entire; urosteges 24.

Color plum-brown, the scales of three or four lateral rows slightly pale on the edges. In old specimens the gastrosteges are similarly colored with pale edges, but in younger specimens, there are at intervals pale spots, and the throat and chin are pale, probably pale yellow in life. In young specimens a yellow band crosses from one angle of the mouth to the other, involving the anterior three-quarters of the parietal plates. In larger specimens this is indistinct, and in a large specimen (455 mm.) the band has disappeared.

Dimensions of a medium sized specimen: total length M. .338; to canthus oris, .008; of tail, .051. Dimensions of the largest specimen: total length, .455; to canthus oris, .009; of tail, .045.

I owe six specimens of this species, representing different ages, to my friend Dr. Santiago Bernad. They are all from the high land about Zacualtipan.

This species represents the extensive genus Rhabdosoma D. & B., of which I know eight species as found within the limits of Mexico and Central America, and as many from more southern parts of the neotropical realm. This genus I propose to retain as distinct from the Elapoidis of Boie (Catastoma and Geophis of Wagler), on account of the smooth scales. In the latter they are more or less carinate. There are five species of Elapoidis in the neotropical region north of Darien. Differing from both of these in its divided anal scutum, is the genus Adelphicus of Jan. This name of Jan has priority over Rhegnops Cope, which is identical. The Rhabdosoma of Bocourt is not the same, as I have else-

where stated.* I was led to believe this to be the case, on account of the statement of Bocourt in his generic diagnosis that the anal plate is divided; whereas in his descriptions and figures they are represented as entire. The following is a synopsis of the species of Rhabdosoma found north of Darien.

I. One pair of geneial plates.

R. zebrinum Jan.

II. Two pairs of geneial plates.

α. Two postoculars.

R. bicolor Günth.=*Rhabdosoma hoffmanni* Jan. Iconogr. Gen. des Ophidiens.

αα. One postocular.

β. First pair of inferior labials separated.

R. rostrale Jan.

ββ. First pair of inferior labials in contact.

γ. Seven superior labials.

R. nasale Cope.

γγ. Six superior labials.

R. mutitorques Cope.

R. guttulatum Cope, sp. nov.

Head rather short and wide, and slightly distinct from the body. Scales in seventeen entirely smooth rows. Two pairs of geneials, the posterior in contact, and one half as long as the anterior. Superior labials six, the first and second higher than long; the third and fourth, which bound the eye, longer than high, as is the sixth; fifth long as high, and in contact with the parietal without intervention of a temporal, as in *R. tricolor*. Eye not very small; the superciliary plate several times as large as the postocular. Parietals rather short. Frontal as long as wide, the anterior border gently convex. One temporal between parietal and sixth superior labial. Gastrosteges, 157; one anal; urosteges, 39. Total length, .313; to rictus oris, .009; of tail, .051.

Color above, uniform brown, with a reddish tinge; below, uniform yellowish. The four lowest rows of scales on each side have a yellow spot at the tip, which becomes larger inferiorly. On the first row of scales the brown is reduced to a spot at the base of each scale.

This species is allied to the *R. mutitorques*, but differs in various minor details. The proportions of the head are more like those of a Ninia. The prefrontals are shorter, and the frontal is longer. The eyes are larger, so that the labials below it are not so high. The superciliary plate is much larger, and the temporal present in *R. mutitorques* is absent in *M. guttulatus*. The color is different. There are three specimens of the *R. guttulatus* in the collections of the National Museum at Washington, all brought from the State of Vera Cruz by Messrs. Sartorius and Sumichrast.

* Proceeds. Amer. Philos. Soc., 1885, p. 178.

$\gamma\gamma\gamma$. Five superior labials.

R. semidoliatum D. & B.

The American species of Elapoidis are the following: *E. chalybæus* Wagl. (*E. sieboldii* Jan.); *E. psephotus* Cope; *E. dolichocephalus* Cope; *E. brachycephalus* Cope, and *E. dugesi* Boc. (*Geophis dugesi* Bocourt).

STORERIA OCCIPITOMACULATA Storer. The most southern locality yet noted for this species. The *S. tropica* Cope has the head shields of this species, but the squamation of the *S. dekayi*.

EUTÆNIA SUMICHRASTI Cope.

EUTÆNIA PULCHRILATUS Cope.

SIBON ANNULATUM L.

CROTALUS TRISERIATUS Wagl.

III. GENERAL NOTES.

EUTÆNIA INSIGNIARUM Cope. Proceeds. Amer. Philosophical Society, 1884, p. 172, and

E. MELANOGASTER Jan. Iconographie Generale des Ophidiens.

I am indebted to my excellent friend, Dr. Julius Flohr, of the city of Mexico, for a canoe excursion on the lake Xochimilco, which is seventeen miles from the city, in the valley of Mexico. Here I had an opportunity of seeing the botany and zoölogy of the very irregular shores, which are so curiously constructed by the art of the natives. They are both indented in the form of long, narrow docks, and extended in the form of piers into the waters of the lake. The ends of these piers are sometimes more or less detached below, so as to readily be moved, from which the later statements regarding the floating islands have originated. The piers are planted with crops of vegetables or flowers, which are sold in the adjacent city.

The ends and shores of the piers are the resting place of innumerable water snakes, which can be readily observed from a canoe. The wife of our Indian boatman was particularly acute in detecting these animals before either my friend or myself could see them. We caught a considerable number, and found that they belong to the two species above named. The habits of the two differ somewhat. The *E. insigniarum* is the more active, sooner seeking the water, where it swims, keeping close to the shore, and remaining more or less in sight until it conceals itself in a hole. The *E. melanogaster*, on the other hand, lies quietly so as to be more easily taken in the hand; but, if it once takes to the water, it seeks the depths, and is no more seen. It is much less disposed to bite than the *E. insigniarum*; the latter being, like its ally, the *E. sirtalis*, a very pugnacious snake.

The *E. melanogaster* is one of the few species of the genus which does not possess bands. However, in one specimen I observed a faint trace of a lateral band on each side. It is also variable as to the number of its ocular plates, having them 2–2, 2–3, 1–3, or 2–4, 2–3 being apparently the

most common arrangement. The food of both these species is the *Rana montezumæ* Baird, and another species allied to *R. halecina*. The life of this lake is in other directions exceedingly prolific, especially in fishes and in minute Crustacea.

EUTÆNIA PULCHRILATUS Cope. Proceeds Amer. Philosoph. Society, 1885, p. 174.

This species turns out to be widely distributed in Mexico. Besides the localities already mentioned in this paper, Mr. Hoege sends it from either the valley of Mexico, or the adjacent one of Toluca.

EUTÆNIA FLAVILABRIS Cope. Same locality.*

TOLUCA LINEATA Kenn. A specimen displaying the typical characters, among others those of the genus Toluca, in the extension forwards of the frontal to the internasal plates. Same locality.

TANTILLA CALAMARINA Cope. Same locality.

EUMECES BREVIROSTRIS Gthr. var. A specimen which differs much from the typical ones in coloration. The light lines are very narrow, so as to be separated by four rows of dorsal scales ; and the adjacent edges of the latter are traversed by a blackish line, giving five longitudinal lines for the back. The inferior light line is bordered below by blackish, and below this, two rows of scales have dark adjacent edges, forming lines. Same locality.

HYLA ARENICOLOR Cope. The same region.

IV. COZUMEL ISLAND.

This island is off the east coast of Yucatan, and measures twenty-four miles in length. It was recently visited by the U. S. Fish Commission steamer *Albatross*, and a fine Natural History Collection was made there. The number of reptiles collected is small ; the following is a list of them :

BUFO AGUA Daud. No. 13,907.

ARISTELLIGER IRREGULARIS, sp. nov.

Head rather elongate, narrow to the muzzle. Superior labials nine to the posterior border of the orbit, the seventh and eighth below the middle of the orbit. The symphyseal plate large, with a triangular plate on each side below the first labial, which is the first of a diminishing series of three scales, the fourth being about equal to the adjacent ones. Two small plates connect the lateral triangular ones. Scales of throat and head above minute ; those of the dorsal region of the same and larger and smaller sizes irregularly mixed ; all rounded and convex in form. The larger ones predominate on the sides. Thoracic and abdominal plates small, smooth ; twenty-three longitudinal rows on the belly. A short palpebral spine over the eye. Lamellæ of penultimate digit sixteen. The legs are short, the hinder limb pressed forwards reaching the axilla.

The color is said by Mr. Ridgway, the distinguished ornithologist, who

* Allied to Eutænia is Chilopoma Cope (Rept. U. S. G. G. Surveys, W. of 100 Meridian, G. M. Wheeler, vol. v). This name is preoccupied and may be changed to Stypocemus.

caught the specimen, to be green in life. In alcohol it is pale brown above, varied with a few light points, which are more numerous and distinct on the head. There is an indistinct reticulation on the posterior part of the sides. Labial plates dark brown, the lines of their distinguishing sutures in some cases yellow. Inferior surfaces straw color, except gular region, which is pale brown yellow spotted.

Length to vent, .073 ; do. to line of canthus oris, .013 ; do. to line of posterior borders of auricular meatus, .018 ; do. to axillæ, .035 ; length of anterior limb, .025 ; do. of anterior foot, .010 ; do. of posterior limb, .031 ; do. of postesior foot, .015. The end of the tail is reproduced and so its length cannot be given, but its base is quite robust. No. 13,903.

This species is nearer to the *A. præsignis* Hallow, than the *A. lar* Cope. Both are West Indian in habitat. A fourth species of the genus is described by Bocourt under the name *Idiodactylus georgeënsis*, in the Miss. Sci. Mexique Reptiles, p. 41, and is handsomely figured, Pl. x, fig. 1. It differs from the other species according to Bocourt in the absence of the palpebral spine, and from the *A. irregularis* in the equality of the dorsal scales. It is from the Belize.

SCELOPORUS SCALARIS Wiegm. No. 13,904.

CYCLURA PECTINATA Weigm.

IGNANA TUBERCULATA RHINOLOPHA Weigm.

BASILISCUS VITTATUS Weigm. No. 13,905.

EUTÆNIA RUTILORIS, sp. nov.

Scales in nineteen longitudinal rows, all keeled. Superior labial plates eight, the fourth and fifth below the eye ; the fifth and sixth separated from the parietal by a large temporal, and the seventh separated from the pariental by a single wide temporal. On one side there are two small scales between these large temporals which are wanting on the other side. Loreal as high as long ; one preocular. Internasals as long as prefrontals. Prefrontal elongate, with concave sides, well separated from preoculars. Parietals elongate. Postgeneials longer than pregeneials.

Color brownish-olive, with a pale olive lateral band extending along the third and fourth rows of scales. No dorsal band except for a short distance posterior to the nape, and a very faint trace beyond. Head dark brown above, with a pair of light parietal spots. Superior and inferior labial plates and the first three large gastrosteges reddish-orange or salmon color. Under surfaces everywhere else pale olive, without markings. When the skin is stretched some light spots appear, which give an incomplete outline of a row of quadrate dark spots above the lateral band. No traces of a superior series, although there is space for them.

Total length, M. .755 ; length to canthus oris, .021 ; of tail, .214. Gastrosteges .148 ; one anal ; urosteges 92. No. 18,906.

This species belongs to the *E. saurita* group, but is more robust than the North American species that belong to it. It resembles in coloration and in the keeled first row of scales the *E. sackeni* of Florida. It differs in the

shorter tail, which is one-third the length in the *E. sackeni*, in the eight superior labials, and in the generally stouter proportions, as well as in the red lips.

PSEUDEMYS ORNATA Bell.

CINOSTERNUM LEUCOSTOMUM Dum. 18,910–11–12–13.

This is a variable species. Two specimens from Tehuantepec from Sumichrast (Nos. 141 and 76, Coll. Sumichrast), both males, are rather wider and more dępressed than are specimens from Tobasco and Cozumel. The posterior lobe of the plastron expands abruptly at the base on each side. In nine specimens from Tobasco from Dr. Berendt, the posterior lobe displays its lateral convexity behind the base on each side ; the anterior lobe is more accuminately rounded, and the shell is less depressed. *None of these specimens have axillary scuta.* Four specimens from Cozemel are intermediate in the form of the lobes of the plastron The carapace is rather elevated, and exhibits traces of those keels as do the others.

The species of this genus which inhabit Mexico, with which I am acquainted, are the following :

I. Carapace with three distinct longitudinal keels above.

Carapace flat, depressed............................*C. scorpioides* Wagl.

Carapace compressed, elevated......................*C. shavianum** Bell.

II. Carapace without distinct keels.

a. Axillary scuta rudimental or wanting and not reaching the inguinals. Plastron entire posteriorly.

Inguinal plate mostly behind posterior hinge ; gular very small..........
C. brevigulare† Cope.

Inguinal plate large, in front of posterior hinge ; gular large.............
C. leucostomum Dum.

* *C. mexicanum* Lec. *C. cruentatum* A. Dum.

† *C. leucostomum* "Dum." Cope. Journal Academy Phila., 1875, p. 153. Two specimens from Costa Rica represent this species, which is clearly distinct from the *C. leucostomum*. Besides the two characters above mentioned, it differs from the *C. leucostomum* in the sudden enlargement of the penultimate marginal scute as compared with the antepenult; the former is much elevated, the latter is very narrow in the horizontal direction. In *C. leucostomum* the size of these plates is graduated. The long diameter of the gular scute is less than two-fifths the length of the anterior lobe of the plastron; it is from one-half to two-thirds the same dimension in the *C. leucostomum*. The free lobes of the plastron are relatively larger than in *C leucostomum*. The fixed portion is .75 of the anterior, and .66 of the posterior lobe; in *C. leucostomum* it is nearly equal to the anterior, and is .75 of the posterior. It also differs from the same species, in having no trace of median or lateral keels of the carapace. Of the two specimens, one, probably a male, is a little more elevated and a little narrower than the other. The measurements of the two are ♂: length M. .144; width, .089; of the ♀: length, .127; width, .083. The axillary plate, as in *C. leucostomum*, is mostly in front of the axilla. The inguinal plate on the other hand is much shorter anteriorly, where it narrows to a point, and extends even further posterior to the posterior hinge-line, which is not the case in *C. leucostomum*.

From the Tierra Caliente of Costa Rica at Sipurio, on the east coast. Discovered by Dr. Wm. M. Gabb.

aa. Axillary scuta larger, reaching the inguinal; plastron notched behind.

Carapace narrower; bridge not grooved behind; posterior lobe of plastron longer.................................*C. hirtipes* Wagl.

Carapace wider; bridge grooved behind; posterior lobe of plastron very short..............................*C. flavescens* Agass.

V. NOTES ON ANOLES.

ANOLIS AUREOLUS, sp. nov.

Belongs to the group of the genus with round tail and smooth ventral scales.

The facial ridges are distinct, but obtuse, and soon disappear, and enclose a shallow concavity. The supraorbital scuta are separated on the middle line by one or two rows of scales, and are distinct on the sides of the front, but disappear without reaching the canthal row. They are separated at the facial concavity by six rows of flat, smooth scales. The occipital scale is moderate, equaling the auricular meatus in size, and is separated from the supraorbitals by four rows of scales. The supraoculars form a disc of six scales, which is longer than wide, with a row of four or five scales of intermediate size on the external side. Six rows of loreal scales. Infralabials smaller than the inferior labials, but distinguishable from the mental scales.

Head rather short and wide, shorter than the tibia (including the heel). The hind limb extended reaches to the end of the muzzle. Digital dilatations moderate. Fan not large. Lateral scales granular; a few median dorsal rows not quite so large as the ventrals, weakly keeled.

Measurements.	M.
Length of vent	.040
" " auricular meatus	.011
" " axilla	.0183
" " fore leg	.0192
" " femur	.011
" " tibia (with heel)	.012
" " posterior foot	.0154
Width of head just behind orbits	

This species belongs to the group to which pertain the small species, *A. trochilus, roderiguesi, guentheri, bransfordi,* etc. I have five specimens of the *A. aureolus,* and comparison is not difficult with the species named in view of the good descriptions and figures given by Bocourt in the Mission Scientifique du Mexique. To simplify the comparison I throw it in tabular form:

a. Series of supraorbital plates separated medially.

b. Continued as distinct on the front.

c. Continued to the series of the canthus rostralis.

Six supraocular scales ; one row between supraorbitals ; muzzle elongate ; six interrugal rows ; median dorsals small, weakly keeled ; ear opening large .... *A. roderiguesi.*

cc. Not continued to canthal series.

About twelve supraoculars, of which three are largest ; three rows between supraorbitals ; muzzle longer ; nine interrugal rows ; median dorsals smooth ; ear large................*A. trochilus.*

Six principal supraoculars ; one or two rows between supraorbitals ; six rows interrugals ; muzzle short ; median dorsals small, weakly keeled ; ear large........................*A. aureolus.*

"Fifteen supraoculars ; one or two rows between supraorbitals ; ear small, less than occipital plate." (Bocourt)........*A. guentherii.*

Twelve supraoculars ; one row between supraorbitals, six rows of interrugals ; ear large ; muzzle short...............*A. bransfordii.*

"Eight to ten keeled supraoculars ; one row between supraorbitals ; one interrugal row ; ear opening small, less than occipital scale ; scales of front and muzzle tricarinate"...*A. baccatus.*

aa. Supraorbital scales in contact medially.

"Ten or twelve supraoculars ; scales of muzzle smooth ; ear opening small, much less than occipital plate." (Bocourt) *A. bouvierii.*

Of the *Anolis aureolus* the Smithsonian Institution possesses four specimens from Yucatan, obtained by Arthur Schott, and two specimens from Guatemala sent by Henry Hague.

Color above golden gray ; below (in alchohol) light golden yellow. The females are tinged with brown above, and have a trace of a yellowish dorsal band. In two of the males there are three small black quadrangular spots on the middle line of the nape and back separated by wide spaces.

ANOLIS QUAGGULUS, sp. nov.

Belonging to the section of the genus with round tail and keeled ventral scales.

There are seven rows of truncate and keeled dorsal scales, which are much larger than the ventrals, or the granular laterals, from which they are abruptly distinguished. Muzzle short and narrowed. Supraorbital series separated by three rows of keeled scales, and continued well on muzzle, but not to the canthus rostralis. They are separated on the muzzle by four rows of polygonal, nearly smooth scales. Facial rugæ obsolete ; facial concavity shallow. The supraocular disc consists of two principal large longitudinal median scuta, surrounded by seven or eight smaller ones. Occipital scale little larger than those by which it is surrounded, two of which separated it from the supraorbitals. Auricular meatus much larger. Five rows of loreal, and one row of suborbital scales. Tibia shorter than head. Infralabials very narrow, keeled. When the posterior limb is extended forwards the end of the longest toe marks

the front of the orbit. Scales on exposed surfaces of femur and forearm large, keeled. Fan large.

The general color is a golden green. On the back is a series of blackish chevrons, with the angle directed posteriorly, and with the lateral branches thickened anteriorly. From the apex of each branch a delicate blackish line descends vertically, stopping on the side below its middle, thus dividing the side into vertical areas. Head more yellow above; limbs reddish brown.

Measurements.	M.
Length to vent	.0325
" " auricular meatus	.0090
Width at " "	.0058
Length of anterior limb	.015
" " posterior limb	.0265
" " femur	.008
" " posterior foot	.011

This species is allied to the *A. tropidonotus* Pet. and the *A. uniformis* M., coming nearest the latter in its scutellation. The scales of the head are however quite different, and the dorsal scales less numerous and of a different form. The color is unlike anything hitherto observed in the genus.

One specimen from the San Juan river, Nicaragua, obtained by Robert Kennicott.

ANOLIS UNIFORMIS, sp. nov.

This species is very near to the *Anolis tropidonotus* of Peters, and I should hesitate to separate it had I not a considerable number of specimens of both. The differences are three. First, the equality in size between all the scales of the frontal region, so that the supraorbitals cannot be distinguished by size; second, the smaller number of rows of larger dorsal scales, and third, the uniformily smaller size. The color also differs in all the specimens.

The dorsal scales are in 10–12 rows, while in the *A. tropidonotus* they are in 14–16 rows; in both the scales are imbricate and not truncate. There are three rows of supraoculars which are in contact with the supraorbitals as far as they go, the middle two only being larger than the rest. There are five rows between the anterior prolongation of the supraorbitals on the muzzle. All the scales have one strong keel; those round the small occipital consisting of little more than a longitudinal keel. Facial rugæ obsolete; cavity slight. Auricular meatus much larger than occipital plate. The extended hind leg does not quite attain the nostril; tibia a little shorter than the short head. Seven rows of loreal scales; and two of suborbitals. Infralabials small, keeled.

The color is reddish brown above and greenish below, limbs and head above brown.

Measurements.	M.
Length to vent	.0365
" " auricular meatus	.0120
" of fore leg	.0180
Width of head behind orbits	.0880

Many specimens from Guatemala from Henry Hague, and one from Yucatan from Arthur Schott.

VI. A SYNOPSIS OF THE MEXICAN SPECIES OF THE GENUS SCELOPORUS Wieg.

The genus Sceloporus, as is well known, consists of terrestrial, and therefore depressed thoracopleurous Iguanidæ, with flat scales and distinct parietal scuta, and femoral pores, without preanal pores and gular dermal fold or collar. Its especial habitat is Mexico and Central America, the south-western parts of the United States and California. A single species ranges over the entire eastern district of the Nearctic Realm. Outside of the districts named it does not occur.

The species are rather numerous, but their exact number has been uncertain. It is with the view of determining this question that the present investigation has been undertaken. Since Wiegmann described the most abundant of the Mexican species, synopses have been published by Duméril and Bibron and Bocourt. The latter author has published also, in the Report of the Mission Scientifique of Mexico, most admirable plates of many of the species. The material which has furnished the basis of the present paper is largely the property of the National Museum of Washington. It has been furnished by the following naturalists: Messrs. Riotte, Van Patten, Hague, Berendt, Sumichrast, Xantus, Sartorius, Dugés, Potts and Major. On my own part, I have received specimens from Messrs. Dugés, Hoege, Ferrari-Perez, Villada, Herrera and Bernad. To all of these gentlemen I wish to extend my thanks for their kind attention in the matter.

The distinction of many of the species of this genus is not accomplished without difficulty. I recommend it as an excellent *pièce de résistance* for those persons who do not believe in the doctrine of derivation of species. There are some characters, it is true, which are not subject to such variation as to be embarrassing. Such are the greater or less number of femoral pores, and the granular lateral scales of some of the species. The carination and wrinkling of the head-scales is frequently a valid character, but is especially unreliable in the *S. undulatus*, and one or two other species. The size of the dorsal scales varies in most of the species; the number entering a head length varying two to three in the large scaled spaces, and three or four in the small-scaled ones. The division of the supraocular plates into two or more rows is constant in a few species only; in others it is variable, notably in the *S. torquatus*. The longitudinal division of the anterior frontal is constant in the *S. variabilis*, *S. siniferus* and *S. squamo-*

sus, but is present or absent indifferently in several others. The number of supraoculars in the principal row may be four or five in most of the species.

The greatest difficulty is experienced in distinguishing the North American species. They are much fewer in number than has been represented to be the case, and the few that are admissible do not present the strong characteristics that most of those of more southern regions. The *S. undulatus* has an almost continental distribution in North America, within the range of temperate and subtropical climates.

In the following synopsis little attention is devoted to coloration, for although it furnishes important characters in many of the species, in others it is less distinctive. This part of the description is left for a fuller monograph.

I acknowledge here the aid I have derived from M. Bocourt's work already cited. This naturalist in identifying and figuring the types of Wiegmann, has rendered an important service to herpetology.

I. Femoral pores 2–6.

Facial scales smooth; supraoculars wide; one parietal plate; two canthals; no collar ....*S. horridus.*

Facial scales keeled; laterals smaller than dorsals, directed upwards and backwards; two canthals; two parietals; colors bright. . .*S. siniferus.*

Facial scales keeled; laterals smaller, directed upwards and backwards; two parietals; one canthal; colors dull. .... *S. squamosus.*

II. Femoral pores ten and more.

A Scales of the sides granular.

Facial scales keeled; supraoculars wide; both frontals divided; parietals two; canthals two; ten scales in head length........... *S. utiformis.*

AA. Scales of sides squamous.

* Facial scales keeled or wrinkled.

† One scale on canthus rostralis.

One parietal; twelve dorsal scales in a head length....... *S. chrysostictus.*

†† Two scales on canthus rostralis.

Lateral scales equal dorsal, longitudinal; anterior frontal single; supraoculars long; two parietals .... *S. scalaris.*

Like *æneus*, but head and limbs shorter; supraoculars short; 8 scales in a head length, color green................................. *S. æneus.*

Lateral scales smaller than dorsals, directed obliquely; supraoculars short, anterior frontal divided; two parietals .... *S. variabilis.*

** Facial scales smooth.

† No color band across nape.

‡ One scale on canthus rostralis.

Dorsal scales converging to the middle line; two small parietals; two rows blue spots on the belly...................... *S. pyrrhocephalus.*

Dorsal scales in parallel rows; one large parietal; belly unspotted......
S. malachiticus.

‡‡ Two scales on the canthus rostralis.

‖ Scales small; 12–22 in a head length.

§ One row of large supraoculars, with granulars.

Three parietals ; 14–15 scales in a head length ; color in longitudinal bands...*S. graciosus.*

§§ Two or more rows of flat supraoculars.

Three or two parietals ; 12–15 scales in a head length ; no bands......... *S. grammicus.*

Three parietals ; 18–22 scales in a head length ; color in narrow cross-lines ....*S. microlepidotus.*

‖‖ Scales larger ; ten and fewer in a head length.

§ Two or more distinct parietals on each side.

Three parietals ; 9–10 scales in a head length ; two or more bands ; no collar...*S. consobrinus.*

Two parietals ; no bands, a black collar from shoulder to shoulder across throat...*S. viviparus.*

§§ One parietal ; sometimes a minute one on its posterior border.

a. One row of large supraocular scales.

b. Scales on side of neck and shoulder smaller.

Two rows of spots on back.................................*S. biseriatus.*

bb. Scales of side of neck, etc., larger.

Parietal scales not wider than interparietal, which is not wider than long ; 9–10 scales in a head length ; femoral pores 12–17......*S. undulatus.*

Like *undulatus,* but larger ; femoral pores 10 ; throat not blue ; brown spotted above.......................................*S. spinosus.*

Parietal scales wider than interparietal, which is not wider than long ; 6–7 scales in a head length..........................*S. zosteromus.*

Parietal scales as wide as interparietal, and all wider than long ; 7 scales in a head length ....*S. melanorhinus.*

aa. Two rows of large supraocular scales.

One narrow parietal on each side ; a black vertical spot on each scapula ; green..*S. tæniocnemis.*

†† A dark band or collar crossing the nape (sometimes interrupted).

1. Dorsal scales in parallel series.

α. Dorsal scales in 25–35 series between occiput and groin.

β. One canthal scale ; dorsals strongly mucronate ; one row of large supraoculars.

"Collar incomplete above ; head less than one-fifth of length of head and body ; throat blue ;" Bocourt..............................*S. lunæi.*

Collar very narrow, not pale bordered ; a little interrupted above ; head less than one-fourth of head and body ; throat dark slate, yellow spotted..*S. ferrariperezi.*

Collar complete, yellow bordered before and behind ; head about one-fifth head and body ; throat, belly and groin black.......*S. melanogaster.*

ββ. Two canthal scales.

One large row of supraorbitals ; dorsal scales strongly mucronate ; collar distinctly interrupted at middle, yellow bordered ; throat and middle of belly yellowish-green..................................*serrifer.*

"One large row of supraorbitals; dorsal scales strongly mucronate; throat and sides of belly blue; collar complete, not light bordered".. *acanthinus.*

One or two rows of large supraorbitals; dorsals not or but little mucronate; collar complete, light bordered; sides of belly blue, throat greenish or spotted..*torquatus.*

aa. About forty scales between occiput and groin.

Two canthal scales; dorsals not mucronate; one row of large supraoculars; collar complete, pale-bordered........................*jarrovii.*

aaa. About fifty scales between occiput and groin.

Two rows of larger supraocular scales; collar complete, light bordered.... *ornatus.*

2. Dorsal series of scales converging to the middle line posteriorly.

Forty-three scales between occiput and groin; two canthal scales; two rows larger supraoculars; collar a narrow black line directed backwards from each shoulder, pale bordered behind, mostly interrupted; throat not blue..*dugesi.*

SCELOPORUS HORRIDUS Wiegmann, Herpetologia Mexicana, pt. i, 1834, p. 50. *Tropidolepidus horridus* Dum. Bibr., Erpet. Générale, iv, 1837, 306. Bocourt, Comission Scientifique Mexique, p. 178, pl. xviii, 8, 8a, 8b. *Sceloporous oligoporus* Cope, Proceeds. Acad. Philada., 1864, p. 177.

Colima, *J. Xantus, A. Dugês;* Guadalaxara, *Major;* Vera Cruz, *Comm. Scientifique.*

SCELOPORUS SINIFERUS Cope, Proceeds. American Philosoph. Soc., 1869, p. 159. *Sceloporus humeralis* Bocourt, Mission Scientifique, 1875, p. 206; pl. xviii, bis figs. 3, 3a, 3b.

Tehuantepec, *Sumichrast;* Oaxaca, *Sallé.*

SCELOPORUS SQUAMOSUS Bocourt, Mission Scientifique Mexique, 1875, 212, pl. xviii, bis 7, 7a, 7b, 7c; xix fig. 3.

Costa Rica, *Van Patten;* Guatemala, *Miss. Scientif.*

SCELOPORUS UTIFORMIS Cope, Proceeds. Academy, Philada., 1864, p. 177; Bocourt, Miss. Sci. Mex., 187, p. 208; pl. xviii, bis, 6, 6a, 6b.

Colima, *J. Xantus, Dugês.*

SCELOPORUS CHRYSOSTICTUS Cope, Proceeds. Academy, Philadelphia, 1866, p. 125. *Sceloporus cupreus* Bocourt, Miss. Scientif. Mex, 1875, p. 210; pl. xviii, bis 2, 2a, 2b.

Yucatan, *Schott;* Guatemala, *Van Patten;* Oaxaca, *Boucard.*

SCELOPORUS SCALARIS Wiegmann, Herpetol. Mexicana, 1834, p. 52, tab. 8, fig. 2. *Tropidolepis scalaris* Dum. Bibr., Erpet. Gen., iv, 1837, p. 310. *Sceloporus scalaris* Baird, U. S. Mexican Boundary Survey, Reptiles, p. 6. Bocourt, Miss. Scient. Mexique, p. 202, 1875; pl. xviii, bis, 9, 9a, 9b.

Colima, *Dugês;* Cuernavaca, *Mehédin;* City of Mexico, *Cope;* Zacual-

tipan Hidalgo, *Cope;* Orizaba *Sumichrast;* Monterey, *Cope;* S. W. Texas, *Marnoch;* Sonora, *Kennerly.*

SCELOPORUS AENEUS, Wiegmann, Herpet. Mev. 1834, p. 52; *Tropidolepis aeneus,* Dum. et. Bibr. Erp. Gen. t. iv, 1837, p. 309; *Sceloporus aeneus,* Fitzinger, Syst. Rept., 1843, p. 75; *Tropidolepis aeneus,* Gray, Cat. Brit. Mus., 1845, p. 210; Id. Aug. Duméril, Cat. Mus., Paris, 1851, p. 78; *Sceloporus aeneus,* Bocourt, Com. Sci. du Mex., iii, Rept. p. 204. pl. xviii, bis, fig. 4, 4a, 4b.

"Mexico," *Boucard;* Jalapa, *Flohr.*

SCELOPORUS VARIABILIS Wiegmann, Herpetologia Mexicana, 1834, p. 51; Bocourt, Miss. Sci. Mexique, 187 , p. 200, pl. xviii, bis, 1, 1a, 1b, xix, fig. 2. *Tropidolepis variabilis* Dum. Bibr., Erpet. Gen., iv, 1837, p. 308.

Guatemala, both slopes, *Commision Scientifique;* La Union, San Salvador *do.*; Guatemala, *Hague;* Tehuantepec, *Sumichrast;* Orizaba, *Sumichrast;* Mirador, Vera Cruz, *Sartorius;* Xalapa, *Montes de Oca;* Monterey, *Cope.*

SCELOPORUS PYRRHOCEPHALUS Cope, Proceeds. Academy Philada., 1864, p. 177.

Colima, *Xantus;* Guadalaxara, *Major.*

SCELOPORUS MALACHITICUS Cope, Proceeds. Academy Philada., 1864, p. 178. *Sceloporus smaragdinus* Bocourt, Mission Scientifique Mexique, 1875, p. 186, pl. xviii, figs. 6, 6a 6b; xix, figs. 11a, 11b.

Costa Rica, *Riotte, Gabb;* Guatemala, *Hague, Salvin, Van Patten;* Yucatan, *Schott.*

SCELOPORUS GRACIOSUS Bd. Gird., Proceeds. Acad. Philada., 1852, p. 69, Stansbury's Report Grt. Salt Lake, 1852, 346, pl. v, fig. 1. Bocourt, Miss. Sci. Mexique. *Sceloporus gracilis* Bd. Gird., Proceeds. Acad. Philada., 1852, 175, Girard Herpetol. U. S. Ex. Exped., 1858, pl. xx, fig. 1–9.

Salt Lake City, Utah., Pitt river, California, *Newberry;* Owen's valley, Cal., *Horn;* Southern Oregon, *Cope.*

SCELOPORUS GRAMMICUS Wiegm., Herpetol. Mexicana, pt. i, 1834, p. 51; etiam Isis von Oken, p. 369, exclus. var. *microlepidota;* Bocourt, Miss. Sci. Mex., 187 , p. 192, pl. xviii, bis 12, 12a, 12b; *Sceloporus heterurus* Cope, Proceeds. Acad. Philada., 1866 p. 332.

Tehuantepec, *Sumichrast;* Mirador, Vera Cruz, *Sartorius.*

SCELOPORUS MICROLEPIDOTUS Wiegmann, Herpetol. Mexicana, 1834, p. 51; Bocourt, Miss. Sci. Mexique, p. 194, pl. xviii, bis figs. 13, 13a, 13b, 13c, 13d. *Tropidolepis microlepidotus* Dum. Bibr., Erp. Gen., iv, 1837, p. 307.

Colima, *Ghiesbrecht;* Puebla, *Dugès, Ferrari-Perez;* Oaxaca, *Boucard;* Toluca, *Villada;* Zacualtipan, *Bernad, Cope;* Mirador, Vera Cruz, *Sartorius;* Orizaba, *Sumichrast;* Guanajuato, *Dugès.*

SCELOPORUS CONSOBRINUS Baird Girard, Marcy's Report on Red river,

1853, p. 237. *Sceloporus garmani* Boulenger, Proceeds, Zool. Soc. London, 1884.

Ogden, Utah, *Hayden*.

SCELOPORUS VIVIPARUS Cope, sp. nov.

Scales of back in parallel series, rather large, eight in a head length, strongly keeled and mucronate. Lateral scales but little, abdominal scales a good deal smaller than the dorsals. Lateral series not very oblique. Head scales entirely smooth. One row of wide supraoculars, separated by one row of very small scales from the supraorbitals, and two rows from the superciliaries. Anterior frontal undivided ; interparietal subquadrate ; two parietals on each side. Preauricular scales not larger than temporals ; two canthals. Posterior foot reaching to front border of ear meatus when leg is extended. Femoral pores fifteen. Length of head a little less than one-fourth that of head and body.

Color of males above brown, sometimes green ; of a female, green. Sides of belly blue with a dark internal border; belly, breast and chin straw-color. A black spot in front of the shoulder, which rises into a point just above the humerus, but joins its fellows by a black line round the throat. In front of it, the throat is, for a short distance, pale blue. In the female there are some indistinct dark spots on the sides of the back.

Four specimens from Orizaba, Vera Cruz, *Sumichrast ;* one from Mirador, *Sartorius ;* and one from Tehuantepec, *Sumichrast*. The last named has two rows of larger supraocular scales. The female from Orizaba contains in the oviducts six well-formed young not enclosed in egg shells, which shows that the species is viviparous.

SCELOPORUS BISERIATUS Hallowell, Proceeds. Acad. Philada., 1854–5, p. 93. U. S. Pacific R. R. Survey Report, 1859, Reptiles, p. 6, pl. vi, vii. Bocourt, Mission Scientif. de Mexique, 195, pl. xviii, bis fig. 10, 10a, 10b.

California, *Heerman*, *Lorquin*, *Boucard*.

SCELOPORUS UNDULATUS Wiegmann, Isis, 1828, 369, Bd. Gird., U. S. Pac. R. R. Surveys, Whipple's Report, p. 37 ; Bocourt, Miss. Sci. Mexique 195, pl. xviii, bis figs. 11, 11a, 11b. *Stellio undulatus* Latreille, Hist. Nat. Rept., ii, 1802, p. 40. *Agama undulata* Daudin, Hist. Nat. Rept., iii, 1805, p. 384. *Uromastix undulatus* Green Merrem. *Tropidolepis undulatus* Cuv., Regne Animal, Ed. ii, ii, 1829, p. 38. Gray Catal. Brit. Mus., 1845, 208. Duméril Bibron., Erp. Générale, iv, 1837, p. 298. Holbrook, N. Amer. Herpetol., iii, 1838, p. 58, pl. viii. *Sceloporus occidentalis* Bd. Gird., Proceeds. Acad. Phila., 1852, p. 175. *S. frontalis* Bd. Gird., loc. cit., *Sceloporus longipes* Baird, l. c., 1858, p. 254. *S. dispar* Bd. Gird., l. c., 1852–3, p. 127. *S. floridanus* Baird, l. c., 1858, p. 254.

North America, from ocean to ocean, not south of Arizona and New Mexico.

As already remarked, the wrinkling of the plates of the head of this spe-

cies does not occur in half the individuals. On the other hand, the wide supraocular plates are never divided.

Subspecies SMARAGDINUS Cope, Report U. S. Expl. Surv. W. of 100th meridian. G. M. Wheeler, Vol. v, Zoölogy, p. 572, pl. xxiv, fig. 2.

Differs considerably from the typical *S. undulatus* in color, being either green above, or brown with large green spots transversely arranged.

Great Basin ; Utah, Nevada and Oregon, *Newberry, Henshaw, Cope.*

SCELOPORUS SPINOSUS Wiegmann, Isis, 1828, p. 369 ; *Tropidurus spinosus*, Wagler, Syst. Amph., 1830, p. 146 ; *Tropidolepis spinosus*, Gray, Synops. Rept. in Griffith's Anim. Kingd. t. ix, 1831, p. 43 ; *Sceloporus spinosus*, Wiegmann, Herp. Mex. pars 1, 1834, p. 50, tab. vii, fig. 3 ; *Tropidolepis spinosus*, Dumér. et Bibron, Erp. Gen. t. iv, 1837, p. 304 ; *Sceloporus spinosus*, Fitzinger, Syst. Rept., 1843, p. 75 ; *Tropidolepis spinosus*, Gray, Cat. Liz., Brit. Mus., 1845, p. 209 ; Aug. Duméril, Cat. meth. coll. Rept., 1851, p. 77 ; *Sceloporus spinosus*, Boucourt, Miss. Sci. du Mexique. iii. Rept. p. 174, pl. xviii, fig. 2, *2a*, *2b*.

Guanajuato, *Dugés.*

The *S. spinosus* approaches the *S. undulatus* very closely, differing principally in size and in color, and the smaller number of femoral pores. A Texan form appears to connect the two.

SCELOPORUS ZOSTEROMUS Cope, Proceeds. Acad. Phila., 1863, p. 105. *S. clarki* subsp. *zosteromus* Cope, Check-list, 1875, p. 49.

Lower California, *Xantus, Belding ;* Southern Arizona.

SCELOPORUS MELANORHINUS Bocourt, Ann. des Sciences Naturelles, iii, 1876, p. 85.

Tehuantepec, *Sumichrast ;* Colima, *Xantus.*

SCELOPORUS TÆNIOCNEMIS, sp. nov.

Scales of the back in nearly parallel series, twelve of them equaling the length of the head, keeled and mucronate. Two canthal scales. Anterior frontal not longitudinally divided. Supraocular scales in two larger rows, of which the inner contains four or five scales, and the outer three or two shorter ones. One parietal scale. All the head scales smooth. Scales of sides equal dorsals, their keels directed upwards and backwards ; those of belly smaller and entire. Thirteen femoral pores.

Color above bluish olive, with numerous small irregular black spots. A vertical black spot rises vertically from the shoulder, and is separated from that of the opposite side by a space equal to its length. Inferior surfaces brassy, the sides blue-tinged in front of the groin ; chin blue ; no black collar on throat or nape. Two black bands, separated by a brown one on the posterior face of the thigh.

Length of head and body to vent, M. .040 ; length of head to line of auricular meatus, .011 ; length of posterior leg, .030 ; of posterior foot, .016 ; of tibia, .008.

Guatemala, *Hague.* A single specimen.

SCELOPORUS LUNÆI, Bocourt, Com. Sci. du Mex., iii Rept.; p. 184, pl. xviii, bis fig. 5, 5a, 5b.

Guatemala, *Bocourt.*

SCELOPORUS FERRARIPEREZI, sp. nov.

The species belongs to the *S. torquatus* group, but is quite different. It is of about the size of the *S. dugesi*, and resembles it in coloration, but has entirely different characters of the squamation of the head and body.

Dorsal scales large in parallel rows, 6.5 in a head length, 25 in a line from head to line connecting groins, with well developed keels and mucrones. Lateral scales a little smaller in oblique series, which run upwards and backwards. Ventral scales a good deal smaller. Femoral pores eighteen. Auricular scales not larger than those in front of them. Scales of head smooth, one only in canthal row (in one of five specimens, there are two). Anterior frontal not divided, one row of wide transverse supraoculars, separated from the supraorbitals by one row of scales, and by two smaller rows from the superciliaries. Interparietal plate subquadrate; parietals two on each side. The posterior foot is short, and reaches a little anterior to the meatus auditorius when the posterior leg is extended forwards.

Color above dark olive, below light yellow. A black scapular spot which sends a narrow black line upwards and backwards, which sometimes meets its fellow of the opposite side, but generally fails to do so by one or two scales. Sides of belly bluish slate color; throat dark slate color, with scattered yellow scales. No black collar across throat. A female has scarcely any markings, there being a few brown lines on the scales above and below.

From Dr. Alfred's Dugés; Nos. 9874–76–78–80 and –95. Named in in honor of Dr. Fernando Ferrari-Perez, the energetic chief of the Commision Cientifica of Mexico. ? From Guanajuato.

SCELOPORUS MELANOGASTER, sp. nov.

Dorsal scales in parallel series, large, six of them equaling a head-length, all keeled and strongly mucronate. Lateral scales smaller than dorsals, graduating into the still smaller abdominals. Lateral abdominals mucronate and notched, not keeled. One canthal scale which reaches the large subnareal. A small flat scale on the upper side of the canthus represents the anterior canthal. Supraoculars in one row of five large plates, which are separated by a rather large row from the supraorbitals all round, and by two rows of smaller scales from the superciliaries. Auricular scales large. Eighteen femoral pores. Scales of front entirely smooth; anterior frontal not divided; two parietals. Posterior foot short, scarcely equaling the length of the head, including the auricular meatus.

Color above sea green, with a wide olivaceous band down the median dorsal region. A black nuchal collar of only two scales in width, which has a broad yellow border. The anterior border is divided by three longitudinal striæ of the ground color on adjacent rows of scales. Top of head dark olive. Lips, thorax, middle of abdomen, extending on each side over

the groin, black; chin, throat and sides blue. The collar is a continuation of the black of the thorax.

Length of head and body to vent, M. .116; length of head to posterior line of auricular meatus, .028; length of posterior leg, .068; of hind foot, .031; of tibia, .026.

A male specimen of this species was sent to the National Museum by Dr. Dugés of Guanajuato, Mexico. Associated with it is another specimen apparently of a variety of the *S. torquatus*, with which it agrees in all essential characters. Nevertheless, it agrees with the *S. melanogaster* in the character of its collar and the borders of it. The color below is yellow, with the throat and chin marbled with a very pale blue, between yellow scales. The dorsal region is light brown, and there are four rows of dark brown spots. There are two canthal plates and one row of large supraoculars. No. 9877, National Museum; from Dr. Alfredo Dugés. Probably from Guanajuato.

SCELOPORUS SERRIFER Cope, Proceeds. Academy Philada., 1866, p. 124.

This species is, as supposed by Bocourt, nearly allied to the *S. torquatus*. Of four adults specimens, three have the collar interrupted, and one has it continuous over the nape. In three young specimens the collar is uninterrupted. In none of the adults are there more than ten femoral pores.

Yucatan, *Schott.*

SCELOPORUS ACANTHINUS Bocourt, Mission Scientifique Mexique, iii, Reptiles, 180; pl. xviii, figs. 10, 10*a*, 10*b*; xix, figs. 4, 4a.

St. Augustino, West Gautemala, *Commision Scientifique.*

SCELOPORUS TORQUATUS Greene and Peale; *Agama torquata* Greene and Peale, Journ. Acad. Phila., t. vi, 1827–1828, p. 231; *Sceloporus torquatus* Wiegmann, Isis, 1828, p. 369; *Tropidurus, Sceloporus torquatus* Wiegm., Wagler. Syst. Amph., 1830, p. 146; *Tropidolepis torquatus* Gray, Synops. in Griffith's Anim. King., t. ix, 1831, p. 43. *Sceloporus torquatus* Wiegmann, Herp. Mex., pars. i, 1834, p. 49, tab. vii, fig. 1; *Tropidolepis torquatus* Dum. et Bibr., Erp. Gen., t. iv, 1837, p. 301; *Sceloporus torquatus* Fitzinger, Syst. Rept., 1843, p 75; *Tropidolepis torquatus* Gray. Cat. spec. Liz., 1845, p. 208; Aug. Dumeril, Cat. meth. coll. Rept., 1851, p. 77; *Sceloporus formosus* Wieg., Herp. Mex., pl. i, 1834, p. 50, tab. vii, fig. 2; *Tropidolepis formosus* Dum. et Bibr., Erpet. Gener., t. iv, 1837, p. 303; *Sceloporus formosus* Fitzinger, Syst. Rept.., 1843, p. 75; *Tropidolepis formosus* Gray, Cat. Liz., 1854, p. 209; Aug. Duméril, Cat. meth. coll. Rept., 1851, p. 77. *Sceloporus formosus* Bocourt, Com. Sci. du Mexique, iii Rept., p. 182, pl. xviii, fig. 3, 3a, 3b, 3c. *Sceloporus poinsettii* Baird and Girard, Proc. Acad. Phila., 1852, p. 126; U. S. and Mex. Bound. Survey, 1859, p. 5, pl. xxix, figs. 1–3. Bocourt, Miss. Sci. du Mex., iii Rept., p. 171, pl. xviii, fig. 9, 9a, 9b, 9c.

Colima, *Dugés;* Oaxaca, *Boucard;* Xalapa, *Keating, Montesdeoca;* Vera Cruz, *Sartorius;* Monterey and Laredo, *Cope;* Texas, *Clark.*

The most difficult problems to settle in the genus Sceloporus, are the limits of the species *S. torquatus* and *S. undulatus*. With considerable material, and the experience of Mr. Bocourt before me, I do not feel that I can make more than a contribution to the question as regards the *S. torquatus*. The collection of individuals I include under that name, embraces some with one row of large supraocular plates, and some with two; some with mucronate, and others with entire dorsal scales in numbers varying from twenty-five to thirty-five between occiput and groin; specimens with the anterior collar border divided and those where it is entire; and those with blue and those with gray throat and chin. In the following synopsis of varieties I indicate the localities where they are derived.

I. One row of large supraocular scales.

Dorsal scales not mucronate; collar border not interrupted.. *S. t. torquatus*.

Xalapa, *Keating*.

II. Two rows of large supraocular plates.

Dorsal scales not mucronate; collar border not interrupted; nowhere blue.. *S. t. poinsettii*.

(Four from S. W. Texas, *Cope*, and two from uncertain Mexican localities.)

Dorsal scales not mucronate; collar with anterior border divided; back dark spotted, sometimes with light borders; chin, throat and sides blue.. *S. t. cyanogenys*.

(Seven from Monterey, Nuevo Leon, *Cope*.)

Dorsal scales strongly mucronate; anterior collar border divided, and forming two yellow spots on nape; sides blue; chin and throat not blue.. *S. t. mucronatus*.

(Four from Vera Cruz, *Sartorius*.)

Dorsal scales stongly mucronate, a little smaller (eight equaling head); collar very slightly interrupted, borders very pale; green, sides and narrow inferior collar blue; chin and throat not.. ....*S. t. formosus*.

Four from Xalapa, *Montes de Oca*.

As in *S. t. cyanogenys*, but scales smaller; 8–10 in head; smaller........ *S. t. minor*.

Two specimens from *Dugès;* Zacatecas.

Finally the second form described under *S. melanogaster* may constitute another variety approaching the *S. t. torquatus*, but with the anterior collar border interrupted as in *S. t. cyanogenys*, and the back spotted as in *S. t. formosus*.

Should the interruption of the collar seen in the *S. serrifer* prove to be an inconstant character, that form must be regarded as subordinate to the *S. torquatus*, entering Sect. I, but related to the *S. t. mucronatus*. Should the anterior canthal scale appear in the *S. melanogaster*, nothing but color will distinguish it from the *S. t. torquatus*, but the strongly mucronate scales, and the very different color, which are, however, weakened in importance by the *S. t. mucronatus* with similiar scales, and the *S. t. cyanogenys* with its blue chin and throat.

The definition of the *S. t. torquatus* is taken from the type of Peale and Greene, which is preserved in the Museum of the Philadelphia Academy. It is correctly identified and figured by Bocourt.

SCELOPORUS JARROVII Cope, Report U. S. Geol. Expl. Surv. W. of 100th mer. p. 569, pl. xxiii, fig. 2, *2b*, *2c*, *2d*.

Southern Arizona.

SCELOPORUS ORNATUS Baird Girard, Proceeds. Academy Philada., 1858, p. 254. Rept. U. S. Mex. Boundary, Survey, Zool. Reptiles, p. 5.

Patos Coahuila, *Couch*.

SCELOPORUS DUGESI Bocourt, Miss. Sci. Mexique, iii. p. 188; pl. xviii, fig. 7, *7a*, *7b*. *Tropidolepis intermedius* Dugés, La Naturaleza, Mexico, vol. iv, p. 29, pl. i, figs. 21–32.

Guanajuato, *Dugés*.

APPENDIX ON A COLLECTION FROM NEW PROVIDENCE, BAHAMA ISLANDS.

This collection was sent to the Academy of Natural Sciences of Philadelphia by Professor Henry C. Chapman, and was submitted to me for identification by my friend Allan Gentry, Assistant Curator.

TRACHYCEPHALUS SEPTENTRIONALIS Tsch.

LITHODYTES PLANIROSTRIS Cope.

ANOLIS SAGRÆ Bibron.

ANOLIS PRINCIPALIS L. var. PORCATUS Gray.

UNGUALIA MACULATA Bibr.

DIADOPHIS RUBESCENS, sp. nov.

Scales in seventeen longitudinal rows, uniporous. Superior labials eight, the third, fourth and fifth entering the orbit; the fifth higher than long, and the seventh and eighth longer than high. The sixth narrowed and truncate above. Nostril large. Loreal plate with the posterior border oblique and equal to the inferior, and longer than the superior or anterior. Preocular reaching top of head, but not touching frontal. Postoculars two, small. Temporals 1–2, the first in contact with both postoculars and the posterior three labials. Rostral broader than high, not protuberant, barely visible from above. Internasals and prefrontals each subquadrate. Frontal elongate, twice as long as wide in front; superciliary borders a little concave. Parietal plates elongate, common suture not so long as frontal. Gastrosteges, 162; anal divided; urosteges, 119. The teeth are subequal and are rather widely spaced.

Color light reddish-brown above, below dirty white tinged with pink. A brown band from nostril to eye, and a dark shade along the superior borders of the labials posterior to the eye. Labials and chin yellowish; the former very faintly reddish-brown.

Total length, M. .413; of tail, .139.

EXPLANATION OF FIGURES.

Fig. *9a*, p. 184, side view of head, of *Anelytropsis papillosus*, $\frac{3}{1}$ natural size. Fig. *9b*, top of head; and *9c*, inferior view of same, both $\frac{3}{1}$ nat. size.

This figure was published in the previous number of the Proceedings of the Society, May 8th, 1885.

Obituary Notice of William S. Vaux. By Philip H. Law.

(Read before the American Philosophical Society, May 1, 1885.)

William Sansom Vaux was born in Philadelphia, on March 19, A.D. 1811.

He was the eldest son of George Vaux, a member of the Philadelphia Bar, and of Eliza H. Vaux, his wife, a daughter of William Sansom, who was a prominent merchant in the East India trade at a time when Philadelphia formed the centre of the commerce of the United States, and who was also famous for his enterprise in building. Many large blocks of buildings, now largely converted into stores and business offices, remain to testify to his sagacity in appreciating the growth of the City of Philadelphia. Mr. Vaux's parents on both sides were descended from the members of the Society of Friends. His ancestors had been long settled in the Province of Pennsylvania, and had long occupied a prominent and respectable position there. Indeed, I understand that originally they were connected by marriage with the families of George Fox, the founder of the Society of Friends, and of William Penn, the founder of the province which bears his name.

Mr. Vaux, however, in early life left the Society, and became connected with the Episcopal Church. Inheriting as he did large means, Mr. Vaux, was, I believe, never actively engaged in business except in that which was made necessary by the management of the family estates.

He early developed scientific and literary tastes, for the cultivation of which his ample fortune gave him both the leisure and the means.

Particularly was he devoted to mineralogy. In collecting rare specimens, he spared neither time, labor nor money. His collection of rare minerals became one of the most valuable in the United States. In 1834, when about twenty-three, he was elected a member of the Academy of Natural Sciences of Philadelphia; continued an active member all his life; and rose to being one of its Curators, and afterwards Vice-President. He was always a large contributor of money to its support.

Mr. Vaux was one of the founders of the Numismatic and Antiquarian

Society of Philadelphia, and was a frequent attendant at its meetings, and at the time of his death one of the Vice-Presidents.

He was a member of many institutions of learning throughout the United States, and was a large contributor to their financial support. On April 15, 1859, he was elected a member of the American Philosophical Society, but in examining its proceedings I do not find that he made any contribution to them.

Mr. Vaux was married in Philadelphia to Miss Graeff, of that city, but was so unfortunate as to lose his wife some years before his death.

One son only was born to him, who, unhappily for his father, died at an early age ; so that the last years of his life were passed in widowed and childless loneliness.

For some years before his death his health had become infirm, partly from advancing years, and partly from a disease contracted during a winter passed in Rome in one of his last journeys to Europe.

This disease was not, however, the cause of his death, which resulted from a disease of the abdomen in the nature of a tumor-like growth.

He died on May 5, 1882, in the seventy-second year of his age.

Under the provisions of his will, his large collection of minerals, valued at over fifty thousand dollars, has become the property of the Academy of Natural Sciences of Philapelphia.

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*Second Continuation of Researches among the Batrachia of the Coal Measures of Ohio. By E. D. Cope.**

(Read before the American Philosophical Society, June 19, 1885.)

CERCARIOMORPHUS PARVISQUAMIS, gen. et sp. nov.

Char. gen. Represented by a fusiform body which terminates in a long slender cylindric tail, and which is covered with small subquadrate scales quincuncially arranged. No fins or limbs are preserved, and the form of the head cannot be made out. There are some scattered bodies in the body portion, which look like deeply concave vertebræ with the zygapophyses, of batrachians. There are some linear impressions at one point, which resemble the bristle-like rods of many Stegocephali. These are so few as to be of little importance. The scales are like those ot fishes. There are traces of segmentation in the axis of the long tail.

The position of this curious form is quite uncertain. It is quite different from anything observed hitherto in the American coal measures.

* The first continuation of these researches, subsequent to the publication of the Report of the Geological Survey of Ohio, appeared in these Proceedings for February, 1877.

Char. specific. Scales in their present condition with entirely smooth surface. At a distance of .20 m.m. from the base of the tail they are in twenty longitudinal series. At that point the transverse diameter is 140 m.m. The outline contracts rather abruptly to the tail, of which 750 m.m. are preserved. The surface of the tail is obscured by a thin layer of carbonaceous matter not sufficiently thick to obscure scales; but no scales appear. The body, or such part of it as is preserved, measures 900 m.m. in length. The cephalad half of the body is depressed and somewhat disordered; the caudad half is well preserved. Where the undisturbed portion commences the width is 150 m.m. The diameter of the cup of a supposed vertebral centrum is 1.6. m.m.

A tooth of *Pleuracanthus compressus* Newb. lies close to one edge of the body.

Discovered by Samuel Huston.

Anisodexis enchodus, sp. nov.

The generic characters are apparent in the very unequally sized teeth with round section. The portion upon which the species is based is a part of the right ramus of the mandible, which is in the specimen viewed from the inner side. The jaw is obliqely and smoothly truncate from below, for the symphysis and the surface of the bone is smooth. There is a very large tooth near the extremity of the dentary bone. Behind it is an interval equal to three times the diameter of its base, which is followed by a tooth of about one-third the length of the first tooth. Posterior to this one are two teeth of the same size as the second, all being separated from each other by about a tooth's diameter. These are followed by three sub-equal teeth of about two-thirds the length of the first tooth, and separated by about their own diameter from each other. They are all perfectly straight, very acute, and without trace of a cutting edge. The inflection-grooves extend to or a little beyond the middle of the length.

Measurements.	M.
Length of jaw including seven teeth	.031
Depth of ramus at second tooth	.011
Length of first tooth	.0105
" " third tooth	.004
" " sixth "	.0075

The type of the genus is *Anisodexis imbricarius* from the Permian beds. The present species is very much smaller, and the apices of the teeth do not display the opposite cutting edges seen in the *A. imbricarius.*

Discovered by Samuel Huston.

Ceraterpeton divaricatum, sp. nov.

This species is represented by a skull whose superior surface is visible on a block of coal shale. In size it exceeds that of the other two American species, the *C. punctolineatum*, and *C. tenuicorne.* Its epiotic horns are of the straight acute type of the latter species, and its sculpture is also different from that of the *C. punctolineatum.*

The cranium is distinguished by its elongation, the outline of the muzzle being a regular oval. The orbits are situated at about the middle of the length of the skull. A transverse line dividing the skull equally marks the anterior two fifths of the orbit. This proportion distinguishes the species from the *C. tenuicorne,** where the orbit is entirely within the anterior half of the skull. The horns are rather short, and are straight and acute. The lateral border of the skull contracts somewhat to their base on each side. They diverge at an angle of about 45° from the median axis of the skull. The orbits are oval, the transverse being .75 the longitudinal diameter, which is in turn about equal to the interorbital width. The nasal bones are very large, forming the upper surface of the muzzle, and are not distinguishable from the prefrontals, so as apparently to enter by their postero-external angle, into the orbit. Their sculpture consist of sparse thin radiating ridges, which originate near the center of each bone. The frontal bones are rather wide. Their sculpture consists of radiating ridges, which are not very close together, and which originate at a point near the supraorbital border, a little in front of a line which connects the middles of the orbits. On the postfrontal bone the radii run posteriorly. On the parietal they inosculate so as to form coarse fossæ. The teeth are rather small, and their sections at the middle and upwards, are round.

Measurements.	M.
Total length skull on middle line	.053
Length to line of anterior orbital border	.023
Width at middle of orbit (with lower jaw)	.044
Width at base of horns	.040
Interorbital width	.017
Length of horn from base	.0075

Should it turn out that the *Tuditanus obtusus* of the same locality and horizon is founded on a Ceraterpeton which has lost its horns, it may still be distinguished from the present animal by the more anterior position of its orbits. These are so placed that their posterior border is crossed by the transverse median line.

Discovered by Samuel Huston.

CLASPERS OF BATRACHIA. Dr. Anton Fritsch has obtained in the Gaskohle of Bohemia, in connection with specimens of two species of Ophiderpeton, bodies which he believes to belong to the external genitalia. They consist of a curved rod terminating in a secund expansion, whose projecting edge is divided into fine teeth like a comb. Mr. Samuel Huston has obtained at Linton, in Eastern Ohio, at the locality which has furnished the species here described, a similar body, It differs from those described by Fritsch, in the greater curvature of the shaft in the direction to which the teeth present. Its axis is nearly at right angles to that of the body of

* Report of the Geological Survey of Ohio, Palæontology ii, p. 372, Pl. xlii, fig. 2.

the bone. The latter is oval and convex, and its thin edge is divided by fine grooves more closely placed than in the species described by Fritsch, which terminate in fissures separating delicate teeth. See Fauna der Gaskohle und der Kalksteine der Permformation Boehmens, p. 122, Pl. 20.

Similar bodies were found by myself in the fresh-water beds of the Laramie formation of Montana, and described under the name of *Arotus hierogylphicus.* (Bulletin U. S. Geol. Survey Terrs., F. V. Hayden, iii, 1877, p. 574.) The shaft of this body is not curved, and the body is flattened. As specimens of the batrachian genus Scapherpeton are abundant in this formation and locality, it is not unlikely that these comb-like bones are their claspers.

THE BEOTHUK INDIANS.

By Albert S. Gatschet.

First Article.

(*Read before the American Philosophical Society, June 19, 1885.*)

The Beothuk or Red Indians are the aboriginal people of the isle of Newfoundland, and their presence there is attested as early as the sixteenth century. Nevertheless, we cannot consider them as the autochthons of that extensive country, for insular populations must always have originated in some mainland or continent.

HISTORIC NOTES.

Newfoundland was discovered by Sebastian Cabot, on his great northern cruise in 1497, and probably visited also by Gasparo de Cortereal (1500). Although the Indians were not then identified as Beothuks, Cabot noticed that they were *painted with red ochre* and dressed in skins.

In 1527, Oliver Dawbeny saw from his ship *Minion* the inhabitants of Newfoundland passing in a boat; they fled as soon as they perceived that a ship-boat set out to follow them. At Cape Breton, Nova Scotia, savages came aboard his ship; they called the harbor there Cibo, and the name of their chief was Itarey.*

When Jacques Cartier first reached Newfoundland in 1534, he landed on May 10 at Cape Bonavista, in the south-eastern part of the island. He describes the Indians he saw as "of good size, wearing their hair in a bunch on the top of their heads and adorned with feathers." A word of the native language, *adhothues*, is used by him to designate a fish of a rather strange appearance, white of color, with a rabbit-shaped head.†

* Hakluyt's Voyages, ed. London, 1810; iii, pp. 168, 169, 245.

† Piscis unus a Quarterio memoratur, ... magnitudine orcæ, colore plane candido, capite leporino, barbari sua lingua Adhothues appellabant, etc. *Joan. de Laet, Novus Orbis*, Libr. ii, p. 42 (Lugd. Bat., 1633.)

The Indians of "Terra Nova" of the early period are also described in Barcia, Ensayo, pg. 159.

An anonymous Frenchman who wrote in 1539 observes, that the southern coast was then inhabited by tribes which strenuously avoided the meeting with any strangers; their faces were painted or tattooed in lines.

In 1574, Frobisher took with him to England one individual from the island. The explorer Hayes stated (about 1583), that in the south parts his party "found no inhabitants, which, by all likelihood, have abandoned these coastes, the same being so much frequented by Christians. But on the north are sauages altogether harmlesse."*

Whitbourne, who saw the island in 1622, places the abodes of these Indians in the north and west part of the country; they helped the French and Biscayans in the capture of whales and codfish, and in Trinity Bay stole at night sails, hatchets, etc. Bonnycastle (i, 258), thinks that from the first settlement of Newfoundland the Red Indians chiefly inhabited the north, north-east and north-west near the Fogo and Twillingate† Islands, and about White Bay and the interior, surprising at night the fishing stations located there.

After the landing of Micmac Indians from the mainland opposite, the destinies of the Beothuk aborigines began to take another turn. About the beginning of the eighteenth century a body of Micmacs, who speak an Algónkin language, then partly Roman Catholics, came from Nova Scotia, and settled in western Newfoundland as hunters and fishermen. For many years they were at good terms with the Beothuk; but subsequently quarrels arose, and about 1770 a battle was fought between the two tribes at the north end of Grand Pond. J. B. Jukes, from whose *Excursions in Newfoundland* (1842) the above is an extract, gives the proximate number of Micmacs settled on the island in his time at one hundred families, chiefly established on the west side, wandering from Fortune Bay to St. George Bay, White Bay, Bay of Exploits. In 1840 they were all Roman Catholics, and many of them of a low moral order. The Beothuks called the Micmacs Shŏnak, Shawnuk, Shannok, "bad Indians" (Shanung, *Latham*), and stated that they first arrived by a rivulet called Shŏnăk brook, a tributary of the Exploits River; there they met them in battle also.

The Red Indians always were at good terms with the Labradorian Algonkins of the coast and interior: the Naskapi, Montagnais, or as they called them, Shŏudamunk. They mutually visited each others' countries, traded with them, and it is not unfair to conjecture that some Red Indians may be there now after their expulsion from the island, the distance from the continent being only 10–12 miles at the nearest point, the Strait of Belle-Isle.

Since every nation considers the territory which it occupies as belonging to it by natural right, foreigners encroaching upon the hunting and fishing-grounds were of course punished by the Beothuks with all the means which their weakness in numbers could afford; and the constant

* Bonnycastle, Newfoundland in 1842, Vol. i, p. 253.

† The anglicized form of the French name Toulinguet.

pilferings and robberies which the French experienced at the hands of these natives, brought them to such a pitch of exasperation, that they, in the middle of the eighteenth century, offered a reward for every head of a Red Indian. To gain this reward, and also for the value of the fur-skins which they wore, the Micmacs privately shot them. This brought on the above-mentioned conflicts and many other personal encounters.

The English never pursued them with the same hatred as the French. In 1810, Sir Thomas Duckworth issued a proclamation for their protection. In 1827 some benevolent inhabitants of Newfoundland founded a society at St. John's to open communication with the Red Indians, to protect and possibly civilize them. W. E. Cormack, who in 1822 had crossed the island from coast to coast for exploration, and left an "Itinerary" of his expedition, undertook a similar trip with a retinue in 1827, but failed to sight a single individual of the mysterious tribe. The last region where they had been seen were the shores of the River of Exploits and its tributaries; this seems to have been one of their main habitats even in the foregoing centuries. Since then many other travelers have searched for them; but nothing except implements and the remains of their dwellings and stockades were discovered.

TRIBAL NAMES.

The names by which the tribe is known to us are those of "Beothuk," and of "Red Indians."

The name of *Beothuk* has been interpreted differently. Mr. J. P. Howley mentions an Eskimo word bethuc, said to mean *forefoot of deer*, and Rob. Gordon Latham supposed it meant *good night* in their own language, and that the tribe should hence be named the *Good Night Indians*; betheok being the term for "good night" in Mary March's vocabulary. But Indians generally have some other mode of salutation than this; and that word reads in the original manuscript betheoate (not *betheok*, Lloyd); it is evidently a form of the verb baetha *to go home*; and thus its real meaning is: "*I am now going home.*" The spellings of the tribal name found in the vocabularies are Beothuk, Beothick, Bóhathook, Boeothuk and Beathook; beothuk means not only *Red Indian*, of *Newfoundland*, but is also the generic expression for *Indian*, and composes the word haddabothic *body* (and *belly*). Just as many other peoples call themselves by the term *men*, to which *Indian* is here equivalent, it is but natural to assume that the Indians of Newfoundland called themselves by the same word.

Another term Shawatharott or Shawdthārut is given for *Red Indian man* in King's vocabulary; we find also woas-sut *Red Indian woman*, cf. oosuck *wife*; its diminutive woas-eeash, woas-eesh *Red Indian girl*; mozazeesh *Red Indian boy*.

Red Indians was the name given to them by the explorers, fishermen or colonists, because they noticed their habit of painting their utensils, lodges, boats and their own bodies with red ochre. Sebastian Cabot, the discov-

erer, mentions this peculiar habit, and so does J. de Laet, Orbis Novus, pg. 34: "uterque sexus non modum cutem sed et vestimenta rubrica quadam tingit," etc. This ochre they obtained, e. g., at Red Ochre island, Conception Bay, and mixed it with fat or grease to use it as a substance for daubing.

The Micmac Indians called them Macquaejeet, Ulnŏ mequăegit, the Abnakis Ulnōbah (Latham), in which alno, ulno means *man, Indian.*

ETHNOLOGIC NOTES.

From earlier periods we possess but few notices conveying graphic sketches of the appearance and daily life of the Beothuk Indians. The most important have been gathered and published in Lloyd's articles; hence we can afford to be brief on the subject, for the Journal containing his sketches is within easy reach of everybody, who is interested in the matter. We especially recommend Lloyd's first article, with its numerous historic references.

Joann. de Laet, pg. 34 (1633), writes of them as follows: "Statura corporis sunt mediocri, capillis nigris, lata facie, simis naribus, grandibus oculis; mares omnes sunt imberbes; uterque sexus non modo cutem sed et vestimenta rubrica quadam tingit . . . . . Mapalia (*lodges*) quædam atque humiles casas incolunt e lignis in orbem dispositis et in fastigio conjunctis . . . . Vagi sæpius habitationes mutant." De Laet also gives a description of their curious semilunar or crescent-shaped birchbark canoes, resting upon a sharp keel or bottom, and needing considerable ballast to resist upsetting; they were not over twenty feet long, and could carry five men at the utmost. Cf. pictures in Lloyd's Treatises. The Micmac Indians of Newfoundland use skins instead of birch-bark in the manufacture of their canoes; cf. Note to Lloyd, iv, p. 26.

Remains have been found of their wigwams, consisting of a frame of slender poles and covered with birch rind, thirty to forty feet in circumference; about 1810 a group of twelve of these lodges stood near Cat Harbor (Tocque, Newf., p. 504); and many other ruined settlements of theirs were discovered in recent years.

John Peyton describes the Beothuks he saw on Red Indian Lake and elsewhere, as follows (*Jukes*, ii, 126): "They were fierce and savage (dreaded by the whites), lived entirely by fishing and hunting, and made their wigwams of skins, not of bark like the Micmacs; these structures were raised with much skill on wooden platforms. Their dresses were made of deerskins, smeared with ochre, like their implements and persons. They were great thieves, ... and the French had a greater hatred of them than the English." Pg. 132–133, Jukes describes their deer-fences, a series of stockades of trees often running for thirty miles along a river.

Extract from Bonnycastle, p. 266: The Beothuks used the inner bark of *Pinus balsamifera* as food. On the lakes near New Bay, conical winter wigwams (mamatech) were discovered, holding about twenty people each, and vestiges of numerous summer lodges were found in the vicinity;

also square and oblong pits for provisions, steam-bath huts covered with skins and heated with stones. In the burying-places were found radiated iron pyrites to strike fire, cooking vessels, a doll, and wooden images of persons. All this was discovered by Cormack's Expedition, 1827, which crossed the island in search of Red Indians in behalf of the "Beothic Society for the civilization of the native savages."

Lloyd mentions the fact, that the Red Indians obtained fire by igniting the down of the bluejay by sparks struck from two pieces of iron pyrites (v, p. 225). This bird is the Canadian jay, *Corvus canadensis,* and the pyrites is known on the island by the term *mundic,* "flint and steel," which seems to be of Cornish origin (J. P. Howley). They also were supposed to be gifted with witchcraft, for when attacked, they could raise a fog, in which they made their escape. The "Red Indian devil," as seen at Great Lake, was known by the name: *ashmodshim* or *ashmodyim,* "wicked man." J. Peyton thought that if they had any worship at all, it was that of the sun. To Mr. Howley he gave the following picture of their exterior (Lloyd, v, p. 226): "The Beothuks were a much finer and handsomer race than the Micmacs, having more regular features and aquiline noses; nor were they so dark in the skin. They were of middle stature, and of a very active build. They did not appear to be so fond of gaudy colors as their continental neighbors."

To conclude this short exposé of ethnologic peculiarities of the tribe, I quote from Lloyd (v, p. 245) the conclusions embodying the results to which his studies have led him:

"The Beothuks possessed, in many respects, characteristics belonging to many of the tribes inhabiting the North American continent, whilst, on the other hand, they appeared to differ from them in certain peculiarities, which were as follows: Lightness of complexion. The use of trenches in their wigwams for sleeping-places. The peculiar form of their canoes. The custom of living in a state of isolation far apart from the white inhabitants of the island, and their persistent refusal to submit to any attempts to civilize them. The non-domestication of the dog amongst them. The art of making pottery was unknown amongst them."

BIBLIOGRAPHY.

A list of printed books treating of Newfoundland during the period from the discovery up to the year 1810 will be found in Bonnycastle's vol. i, 336–344.

Articles and books on Newfoundland, in which express mention is made of the Beothuk Indians, are contained in the following list, which makes no pretense of being exhaustive:

Chappell, Lieut. Edw., Voyage to Newfoundland, Lond. 1818, 8vo, illustrated. In the chapter treating of "Red Indians," pp. 169–187, he quotes Whitbourne's "Discovrse and Discovery of New Foundland."

Bonnycastle, Sir R. H., Newfoundland in 1842. Two vols. Lond., 1842, 12mo. His chapter on Red Indians embraces i, pp. 251–278.

Jukes, J. B., of the Geolog. Survey. Excursions in and about Newfoundland. Two vols., 8vo, Lond., 1842, 12mo. On the Beothuks cf. ii, 126, 132, 133, 170–175.

Gobineau, Comte A. de; Voyage à Terre-Neuve, Paris, 1861.

Latham, Rob. Gordon; Comparative Philology. London, 1862, 8vo, pp. 453–455.

Perley, Rev. Chas., the history of Newfoundland from the earliest times to the year 1860. Lond., 1863, 8vo (with map). Cf. 338 sqq. The Appendix vii, pp. 506–522, contains extracts from W. E. Cormack's "Itinerary through the central parts of the island," extending from August 30 to the middle of November, 1822.

Tocque, Rev. Ph., Newfoundland as it was, etc. London, 1878; illustr.; pp. 511.

J. Hatton and M. Harvey, Newfoundland, its history, etc. Boston, 1883. On pp. 184–186, vocab. of *Mary March.* (Not seen by me).

Were published in the Journal of Anthropological Institute of Great Britain and Ireland, the following four treatises:

Lloyd, T. G. B., M. A. I., On the Beothucs, a tribe of Red Indians, supposed to be extinct, which formerly inhabited Newfoundland. Vol. iv, 1874, pp. 21–39, with vocabulary of Mary March, taken by the Rev. John Leigh, and presented to Mr. John Peyton.

Lloyd, T. G. B.; A further account of the Beothucs of Newfoundland. Vol. v, 1875, pp. 222–230, with a plate.

Lloyd, T. G. B.; On the Stone Implements of Newfoundland; ibid. pp. 223–248. Three plates.

Busk, Geo., F.R.S., Description of two Beothuc skulls; ibid. pp. 230–232, one plate.

John Cartwright, Remarks on the Situation of the Red Indians, &c.; *unpublished manuscript* of 1768, now in possession of the Protestant Bishop of Newfoundland, and extracted by Mr. Lloyd in his first article; cf. iv, p. 22 sqq.

LANGUAGE OF THE BEOTHUK.

The enumeration of ethnologic peculiarities of the Newfoundland tribe in question is not the main purpose of the present article. The results obtained by former writers from an investigation of their language not proving satisfactory to me, I have subjected the fragments which have reached down to our period to a new chirographic and critical examination, for the purpose of drawing all the conclusions that can fairly be drawn from them for ascertaining affinities, and thereby shed some light upon the origin of the Red Indians. This research I undertook partly on my own impulse, partly upon the earnest solicitation of Mr. James P. Howleys, surveyor and assistant geologist of the Government at St. John's, the capital of Newfoundland. Through his numerous expeditions he has become perfectly familiar with all parts of this large isle, which in the extent of its area (42,000 square miles), closely approaches that of the

State of New York, and has in his long-sustained correspondence with me evinced the greatest interest for all ethnologic problems and questions connected with his "Terra Nova." With accuracy he compared the faulty vocabulary published by Lloyd, and corrected about twenty-five of its misspellings from the original, which is written in a sloven hand; he also gathered many words hitherto unknown from Cormack's manuscript "Notes," and transmitted them all to me.

The information we possess of the Beothuk tongue was chiefly derived from two women, and is almost exclusively of a lexical, not of a grammatic nature. The points deducible from the vocabularies concerning the structure of the verb, noun, and sentence, the formation of compound terms, the prefixes and suffixes of the language are very fragmentary and one-sided. The mode of transcription is so defective that no vocabularies ever have caused me so much trouble and uncertainty as these in obtaining from them results available for science.

The two female informants had lived but a short time among the English-speaking population, and were not sufficiently acquainted with English to inspire much confidence in their accuracy. They were:

1. *Demasduit,* also called Waunathoake, and by the white people Mary March, because captured on the fifth day of *March*, 1819. John Peyton, who carried on considerable salmon fisheries in the north of the island, had suffered much by the depredations of the Beothuk. He and his party met her, her husband and another man of the tribe on the frozen Red Indian Pond, on the principal tributary of Exploits River, engaged them in a fight, killed her husband, and brought herself to St. John's, where she stayed during the rest of the year, and died at sea of a pulmonary disease, on her return home, January 8, 1820, about twenty-three years old. She furnished a vocabulary of her language (about 180 words) to the Rev. John Leigh, who presented it to Mr. John Peyton; it is printed in Lloyd's article, iv, pp. 37–39. A miniature of her will be found in Tocque's Wandering Thoughts, p. 373, and Bonnycastle i, 276, describes her as follows: "Hair like that of an European, black eyes, skin copper color, docile, very active, agreeable in demeanor; in this respect she differed much from the Micmacs and other Indians." Thomas Taylor, a man present at her capture, was still alive in 1884.

2. *Shananditkit* or Shawnadithit, afterwards called Nancy, was, with two daughters, brought to St. John's in 1823 by William Call, starvation being the cause of their surrender. Shananditlit lived in W. E. Cormack's house* until he left the colony, and the daughters returned to their tribe; then stopped at the house of the attorney-general, Mr. Simms, and subsequently at John Peyton's house. About 50 years old, she fell sick and died of consumption in 1829, at the hospital of St. John's. When in 1825 she procured a Beothuk skull for Cormack, she asserted that only fourteen individuals remained of her tribe. Mrs. Peyton, who still lives at

*Mr. Cormack was a man of intellectual acquirements, having followed a course of studies at Edinburgh University.

an advanced age at Toulinguet, Notre Dame Bay (Mr. Peyton died in 1883, over 90 years old), took peculiar charge of Shananditbit and states that drawings made by her are still extant. From her and other sources Cormack obtained a vocabulary, which seems more reliable and phonetically more accurate than the one obtained from Mary March. The phonetics of Beothuk impressed Cormack as "resembling less the other Indian languages than the European;" by the latter he probably meant those spoken upon the British Islands. Together with Beothuk implements, etc., he sent it to the address of Dr. Yates, England.

Further comments on the language, ethnologic and historic remarks on this curious people are reserved for a subsequent article. Below I reproduce the terms written in the same manner as transmitted, using the following abbreviations:

ABBREVIATIONS.

C.—Cormack's vocabulary; obtained from Shananditbit and others.

Howl.—Corrections of Leigh's printed vocabulary from his own manuscript, made by Mr. James P. Howley.

K.—Vocabulary of Dr. King, transmitted by Rob. Gordon Latham, London, in April, 1883. The words were probably furnished by Shananditbit to Cormack.

No Letter.—Rev. John Leigh's vocabulary, obtained from Demasduit.

VOCABULARY.

a-aduth *seal-spear*, C. Cf. amina.

abemite *gaping.*

abideshook; abedésoot K, *domestic cat;* cf. bidesook.

abidish "*martin cat,*" *marten.* Micmacs call him *cat;* the whites of New foundland call a young seal: *cat* or *harp-seal,* because a white design visible on their backs resembles a harp.

abobidress *feathers;* cf. ewinon.

abodoneek *bonnet*, C. abadung-eyk *hat* K.

adadimite or adadimiute; andemin K. *spoon;* cf. a-enamin.

adamadret; adamatret K. *gun, rifle.*

adenishit *stars;* cf. shawwayet *a star* K.

adizabad zea *white wife.*

adjith *to sneeze.*

adoltkhtek, adolthtek K., adolthe; ode ōthyke C. *boat, vessel.* Seems to imply the idea of being pointed or curved; cf. a-aduth, adothook; dhoōrado, tapathook.

adosook K., aa-dāzook C. *eight;* ee-aa dazook *eighteen,* C.

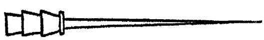
adothook; adooch K. *fishhook.*

adzeech K; adasic; ádzeich C., *two;* ee-adzike *twelve,* C.; adzeich dthoónut *twenty* C.

aduse *leg;* ádyouth *foot* K.

a-enamin *bone,* C.

a-eshemeet *lumpfish,* C.
ae-u-eece *snail,* K.
ae-wā-een C. ; cf. ee-wā-en.
agamet ; aegumet K. *buttons ; money.*
aguathoonet *grindstone.*
ahune, ahunes, oun K. *rocks.* Misspelt ahmee (Lloyd).
ajeedick or vieedisk K. *I like.*
akusthibit (ac- in original) *to kneel.*
amet *awake,* C.
amina *deer-spear* C.
ámshut *to get up ;* cf. amet. Howley supposes this to be from the same word as gamyess, q. v.
anadrik *sore throat ;* cf. tedesheet.
anin *comet ;* cf. anun *spear (in skies?)*
anyemen, ânyēmen, *bow,* K. ; der. from annŏŏ-ee, q. v.
annawhadya *bread,* K. Cf. manjebathook.
annŏŏ-ee *tree ; forest, woods* K.
ânun *spear,* C. cf. a-aduth, amina, anin, annŏŏ ee.
anwoyding *consort ; husband,* when said by wife ; *wife* when said by husband. Cf. zathrook.
a-oseedwit *I am sleepy,* K.
aoujet *snipe : Gallinago wilsonia,* of genus *Scolopacidæ.*
apparet o bidesook *sunken seal.*
ardobeeshe and madobeesh *twine,* K. cf. meroobish.
ashaboo-uth, C. ; iggobauth *blood,* C. cf. ebanthoo.
áshautch *meat ; flesh,* K.
ashei *lean, thin ; sick.*
ashmudyim *devil,* "bad man" C. ; cf. muddy. The spelling of the first syllable is doubtful.
ashwameet, ashumeet, mythological symbol drawn by Shananditħit :



Ashwan, nom. pr., *Eskimo.*
áshwoging C. ; ashoging K,, *arrow ;* cf. dogernat.
asson ; ásson K. *sea-gull.*
áss-soyt *angry,* C.
athess ; áthep K. *to sit down.*
awoodet *singing.*
baasíck *bead,* C., bethec *necklace.*
baasothnut ; beasóthunt, beasothook K. *gunpowder ;* cf. basdic.
badisut *dancing.*
bætha *go home,* K. becket? *where do you go?* bæōdut *out of doors,* or *to go out of doors,* K. These three words all seem to belong to the same verb.
baroodisick *thunder.*

basdic ; basdick K. *smoke ;* cf. baasothnut.
báshedtheek ; beshed K. *six*, C. Rigadosik *six* in Leigh's voc. seems to point to another dialect. Ee-beshedtheek *sixteen*, C.
bashoodite Howl. *to bite.*
bashubet *scratch* (verb ?)
bathuc ; badoese K., watshoosooch K. *rain ;* cf. ebanthoo.
baubooshrat *fish*, K. ; cf. bobboosoret *codfish.*
bebadrook *nipper* (moskito).
bedejamish bewajowite *May*, C. cf. kosthabonóng bewajowit.
beodet *money ;* cf. agamet, baasick.
Beothuk, Beothich K. ; Béhat-hook K. ; Bœothuck (in Howley's corresp.) ; Beathook. (1) *Indian ;* (2) *Red Indian*, viz. Indian of Newfoundland. cf. haddabothic.
berrooick or berroich.*clouds.*
betheoate *good night.*
bibidegemidic *berries ;* cf. manus.
bidesook ; beadzuck, bidesúk K. *seal.* Cf. abideshook, apparet.
bidisoni *sword.*
bituwait *to lie down.*
boad *thumb*, K.
bobbidist Howl. ; bobbodish K. *pigeon* (guillemot, a sea bird). A species of these, very abundant in Newfoundland, is *Lomvia troile.*
bobbiduishemet *lamp ;* cf. boobeeshawt, mondicuet and emet *oil.*
bobboosoret *codfish ;* is the same word as baubooshrat.
bogathŏowytch, *to kill*, K. buhashauwite *to beat.* bobáthoowytch! *beat him!* Beating and killing are frequently expressed by the same term in Indian languages. Cf. datyuns.
bogodoret ; bedoret, bĕdoret K. *heart.*
bogomot or bogomat *breast*, K. boghmoot *woman's breast*, K. bodchmoot *bosom*, C. bemoot *breast*, C. Cf. bogodoret.
boyish *birch bark ;* by-yeech *birch tree*, K.
bŏŏbasha, boobasha *warm*, K. cf. obosheen.
boobeeshawt *fire*, K. cf. bobbiduishemet.
boochauwhit *I am hungry*, K. cf. pokoodoont.
boodowit *duck ;* cf. eesheet, mameshet.
bootzhawet *sleep* (verb ?) K. ; cf. isedoweet.
boos seek *blunt*, C. ; pronounced búsik.
botomet onthermayet ; botothunet outhermayet Howl., *teeth* (?).
bŭhăshămēsh *white boy*, C. buggishămesh *boy*, K.
buhashauwite ; cf. bogathŏowytch.
bukashaman, bookshimon *man ;* buggishaman *white man*, K.
butterweye *tea* K. (English.)
carmtack *to speak*, K. ; ieroothack, jeroothack *speak*, K.
cheashit *to groan.*
cockáboset ; cf. geswat.
dábseek C., dăbzeek K., abodoesic *four ;* ee-dabzook *fourteen*, C.

dattomeish ; dottomeish K. *trout.*
datyuns or datyurs *not kill* (?), K.
dauoosett *I am hungry*, K., probably false ; cf. boochauwhit.
debine Howl., deboin K. *egg.*
deddoweet ; didoweet K., *saw*, subst.
deh-hemin ! Howl. dayhemin ! K. *give me !*
deed-rashow *red*, K.
deiood ! *come with us !* K. dyoom ! *come hither !* K. dyoot thouret ! *come hither !* C. toouet (to) *come*, K. nadyed *you come back*, K.
deyn-yad, pl. deyn-yadrook *bird*, C.
Demasduit, nom. pr. of Mary March.
deschudodoick *to blow*, C.
dho ōrado *large boat*, K., cf. adoltkhtek.
dingyam, dhingyam K., thengyam *clothes.*
dogajavick *fox*, K., cf. deed-rashow *red ;* the common fox is the red fox.
dogernat *arrow*, kind of.
Doodebewshet, nom. pr. of Nancy's mother, C.
doothun *forehead*, K.
dósŏmite K., dosomite *pin.*
drona ; drone-ooch K. *hair ;* the latter form apparently a plural.
dthŏŏnanyen, thinyun *hatchet*, K.
dtho-ónut, C. ; cf. adzeech.
ebanthoo ; ebadoe K. *water.*
ebathook *to drink*, K. ; zebathŏong *to drink water*, K. cf. ebanthoo. bathuc.
edat or edot *fishing line ;* cf. a-aduth, adothook.
edrú or edree ; edachoom K. *otter.*
éjabathook, ejabathhook K., *sail ;* edjabathook *sails.*
ee— composes the numerals of the first decad from 11 to 19; it is prefixed to them and emphasized. Cf. the single numerals.
eeg *fat*, adj.
eenoaja *cold (called ?)* K.
eenódsha *to hear*, K. ; cf. noduera.
eesheet *duck*, K. ; probably abbrev. of mameshet, q. v.
eeshoo *make haste.*
eeseeboon *cap*, K.
eeshang-eyghth *blue*, C.
eewā-en ; aewā-en K., hewhine, ŏ-ŏwin K. *knife ;* cf. oun. Leigh has also : nine, probably misspelt for : wine (wa-en).
egibididuish, K., egibidinish *silk handkerchief.*
ejew *to see*, K. ; pronounced idshu.
emamoose, immămŏose *woman ;* emmamoose *white woman*, K.
emamooset *child ; girl ;* emmamooset *white girl*, K.
emet ; emet K. *oil ;* composes bobbiduishemet and odemet, q. v.
emoethook ; emmathook K. *dogwood* (genus : *Cornus*) or *mountain ash* (*Populus tremuloïdes*).

ethenwit; etherwit Howl. *fork.*
euano *to go out;* enano *go out,* Howl.
ewinon *feather,* K.
gabowcete *breath,* C.
gamyess *get up,* Howl.
gasook or yasook, yosook *dry* K.; gasuck, gassek; K. *stockings.*
gausep *dead,* K.; gosset *death,* and *dead,* K.
geonet *tern, turr,* a sea-swallow: *Lomvia troïle* (also called *Urea troïle*). K. has geonet *fur.*
ge-oun K.; gown *chin.*
geswat *fear,* K,; cockâboset! *no fear! do not be afraid!* K.
gheegnyan, geegn-yan, K., guinya *eye.*
gheen K., geen (or gun?) *nose.*
gidyeathuc *wind.*
gigarimanet K., giggeramanet; giggamahet Howl. *net.*
gobidin *eagle,* C.
godabonyeesh *November,* C.
godabonyegh, *October,* C.
godawik *shovel;* cf. hadowadet.
gonathun-keathut Howl.; cf. keathut.
goosheben *lead* (v. or subst. ?).
gotheyet *ticklas* (tern), a bird of the Genus *Sterna;* species not identifiable, perhaps *macrura,* which is frequent in Newfoundland (H. W. Henshaw).
gowet *scollop* or *frill;* a bivalve, *Pecten.*
guashawit *puffin;* a bird of the *Alcidæ* family: *Lunda cirrhata.*
guashuwit; gwashuwet, whashwitt, wāshāwet K. *bear.*
guathin, cf. keathut.
gungewook Howl. *mainland.*
haddabothic *body;* hadabatheek *belly,* C.; contains beothuk, q. v.
hâdalahét K.; hadibiet *glass,* cf. nâdalahet.
hadowadet *shovel,* K.; cf. godawik.
hanawāsutt *hatfish* or *halibut,* K.
hanyees *finger,* K.
haoot *the devil,* K.
hodamishit *knee.*
homedich, homedick, oomdzech K., *good.*
ibadinnam *to run,* K. cf. wothamashet.
immămooset, cf. emamoose.
isedoweet *to sleep;* cf. bootzhawet.
itweena *thumb,* cf. boad.
iwish *hammer,* K.; cf. mattuis.
jewmetchem, jewmetcheen *soon,* K.
jigganint *gooseberry.*
yaseek C., yāzeek K., gathet *one;* ee-yaziech *eleven,* C.
yeathun, ethath *yes,* K.

yéothoduc *nine*, C.; ee-yéothoduck *nineteen*, C.

yeech *short*, K.

ķaasussabook, causasbow *snow*, K.

kadimishuite *tickle:* a rapid current in a narrow channel of the sea.

kaesinguinyeet *blind*, C.; from gasook *dry*, gheenyan *eye*.

kannabuch *long*, K.

kawingjemeesh *shake hands*, K.

keathut, gonathun-keathut; ge-outhuk K., guathin; *head*. keoosock, kaasook *hill*, K.

kewis, kuis, ewis, keeoose K. *sun; moon; watch*. Kuis *halfmoon:* a mythologic symbol drawn by Shananditbit:

kingiabit *to stand*.

kobshuneesamut (ee accented) *January*, C.

koşhet *to fall*.

kosthabonóng bewajowit *February*, C. For the last part of word, cf. bedejamish bewajowite.

kōsweet K., osweet *deer*.

kowayaseek *July*, C.; contains yazeek *one*.

kusebeet *louse*.

lathun; lathum (?) *trap*, K. cf. shabathoobet.

madabooch *milk*, K.

madyrut *hiccough*.

máduck, máduch *to-morrow*, K.

maemed, maelmēd; mewet *hand*, K.; cf. meesh in kawingjemeesh; meeman monasthus *to shake hands*. memayet *arms*.

magaraguis, magĕragueis *son*, K.

magorun; magorum K. *deer's horns*.

mamashee K.; mamzhing *ship, vessel*.

mamatrabet a long (illegible; *song?*) K.

mameshet; memeshet Howl. *ducks and drakes*. (drake: male duck.) Probably the mallard duck, *Anas boschas*.

mameshook; mamudthun K. *mouth;* cf. memasook.

mammateek, cf. meotick.

mamishet, māmset, mamseet K., māmisut C *alive*. Doodebewshet mamishet gayzoot, or: D. mamsheet gayzhoot, *Doodebewshet is alive*, K. mamset *life* K.

Mamjaesdoo, nom. pr. of Nancy's father.

mammadronit (or -nut) *lord bird;* or *harlequin duck*. Contains: drona.

mammasheek *islands;* cf. mamashee.

māmmăsăveet (or māmmŏosĕrnīt J. Peyton), mamasămeet K., māmudthuk, mamadthut K. *dog*. māmmusemītch, pl. mammasavit *puppy*.

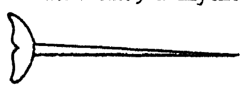
mamshet; maumsheet K. *beaver*. (simply: animal.)

manaboret K., manovoonit Howl. *blanket*.

manamiss *March, month of;* C.

mandeweech, maudweech *bushes*, K.

mandzey, mamdsei K., mandzyke C. *black.*
manjebathook *bread,* C.
manegemethon *shoulder.*
mangaroonish or mangarooaish *sun;* probably *son,* cf. magaraguis.
manune *pitcher, cup.*
manus *berries,* K.; cf. bibidegemidic.
marmeuk *eyebrow.*
mărot *to smell,* K. (v. intr.?)
mássooch, másooch *salt water,* K.
matheoduc *to cry.*
mathık, mattic *stinking;* mattic bidesuk *stinking, rotten seal,* K.; mathic bidesook *stinking seal.* Cf. mărot.
mattuis Howl. *hammer*; cf. iwish.
memasook; mamudth-uk, mamadth-ut K. *tongue;* cf. mameshook.
memayet *arms;* cf. maemed.
meotick, meeootick, mae-adthike K. *house, wigwam.* mammatik *house.* mammateek Howl.: *winter wigwam.* meothick *house, hut, tilt camp,* K. (probably a windbreak).
meroobish *thread;* cf. ardobeeshe.
messiliget-hook *baby,* K.
methabeet *cattle,* K.; nethabete "cows and horses."
miaoth *to fly.*
modthamook *sinew of deer,* K.
moeshwadit *drawing* (?); mohashaudet or meheshaudet *drawing knife* K.
moidensu *comb.*
moisamadrook *wolf.*
mokothut, species of a blunt-nosed *fish,* C.
monasthus (*to touch?*), mecman monasthus *to shake hands.* Cf. maemed.
mondicuet *lamp,* K.; cf. bobbiduishemet.
moocus *elbow.*
Moomesdick, nóm. pr. of Nancy's grandfather.
mooshaman; mootchiman K. *ear.*
mŏosin *moccasin* K.; mosen *shoe,* K.
moosindgei-jebursŭt *ankle,* C.; contains mŏosin.
mossessdeesh, cf. mozazeosh.
motheryet *cream jug;* cf. nádalahet.
mowageenite *iron.*
mowead *trousers,* K.
mozazeosh, mogazeesh; K., *Red Indian boy;* mossessdeesh *Indian boy,* C.
muddy, mandee, K., múd'ti C., *bad; dirty.* mŭdeet *bad man,* C.; cf. ashmudyim.
nádalahet *cream-jug;* cf. hádalahét, motheryet.
nechwa *tobacco,* K.; deh-hemin neechon! *give me tobacco!* Howl.
newin, newim *no,* K.
ninezeek, C., nunyetheek K., nijeek, nijeck *five;* ee-ninezeek *fifteen,* C.
nodluera, *to hear,* K. Cf. eenódsha.

Nonosabasut, nom. pr. of Demasduit's husband; tall 6′ 7½ inches.
oadjameet C., *to boil*, as water; v. trans. or intr.? moodamutt *to boil*, v. trans. C.
obosheen *warming yourself*; cf. bŏŏbasha.
obsedeek *gloves*, K.
obseet *little bird* (species of?), C.
odasweeteeshamut *December*, C.; cf. odusweet.
odemen, ode-emin K., odemet *ochre;* cf. emet.
odensook; odizeet, odo-ezheet K. *goose;* cf. eesheet *duck.*
odishuik *to cut.*
odjet *lobster*, K. and Leigh.
odoit *to eat;* cf. pokoodoont.
odusweet; edusweet K. *hare;* cf. kosweet, odasweeteeshamut.
oŏdrat K., woodrut *fire;* cf. boobeeshawt.
o-odosook; oodzook, C., ode-ŏzook K. *seven*; ee-oodzook *seventeen*, C.
ooish *lip.*
oosuck *wife;* cf. woas-sut.
osavate *to row;* cf. wotha- in: wothamashet.
oseenyet K., ozegeen Howl. *scissors.*
osthuk *tinker* (J. Peyton); also called *guillemot*, a sea bird of the genus *Urea.* Species not identifiable.
oun; cf. ahune.
owasboshno-un (?) C. *whale's tail;* a mythologic emblem drawn by Shananditbit:  Dr. Dawson thinks it is a totem.
ozeru; ozrook K. *ice.*
podibeak; podybear Howl. *oar, paddle.* Cf. osavate.
pokoodoont, pokoodsont, bocootyone *to eat*, K.; cf. odoit.
poochauwhat *to go to bed*, K. cf. a-oseedwit.
pugathoite *to throw.*
quadrauuek; quadranuk K. *gimlet.*
quish *nails.*
shabathoobet Howl., shabathootet *trap.*
shamoth; thămook, shamook, shäamoc K. *capelin;* a fish species.
Shananditbit, C., Shawnadithit, nom. pr. of Nancy, a Beothuk woman.
Shanung, Shŏnack, Shawnuk, Shannok, nom. pr., *Micmac Indian*, Shonack "bad Indians," *Micmacs*; cf. Shō-udamunk.
shápoth K., shaboth *candle.*
shănsee C. and K.; theant *ten.*
Shawatharott, Shawdthărut, nom. pr., *Red Indian man.* Cf. zathrook.
shawwayet *a star;* cf. adenishit.
sheboboweet K., shebohowit; sheebuint C. *woodpecker.*
shebon, sheebin *river, brook*, K.
shedbasing wáthik *upper arm*, C.

shedothun, shedothoon *sugar*, K.
sheedeneesheet *cocklebur*, K.
shegamite *to blow the nose.*
shema bogosthuc *moskito ;* cf. bebadrook.
shendeek C., shendee K., thedsic *three;* ee shendeek *thirteen.* shendeek dthō-ōnut *thirty*, C.
shewthake *grinding stone*, K. ; cf. aguathoonet.
shoe-wana, shuwän *water bucket*, of birch bark ; *drinking cup*, K. shoe-wan-yeesh *small stone vessel*, C. A drawing of a shuwän, made by Shananditbit, has been preserved (Howley).
Shō-udamunk (from Peyton) nom. pr. of the Mountaineer (or Algonkin) Indians of Labrador, *Naskapi*, or "good Indians." Cf. Shanung.
sosheet *bat*, K.
shucododimet K.; shucodimit a plant called *Indian cup.*
tapathook ; dapathook K. *canoe ;* cf. adoltkhtek.
tedesheet *neck ; throat.*
theehone *heaven*, K.
thengyam *clothes ;* cf. dingyam.
thine *I thank you.*
thooret ! *come hither!* abbrev. from the full dyoot thouret, C., cf. deiood !
thoowidgee *to swim.*
toouet ; cf. deiood !
wabee *wet*, K. ; probably misunderstood for *white.*
wadawhegh *August*, C.
wäsemook *salmon*, K. cf. wothamashet.
washa geuis K., washewnish *moon.*
wäshäwet, whashwitt K., cf. guashuwit.
washewtch K. ; washeu *night ; darkness.* Cf. month's names.
washoodiet, wadshōōdet *to shoot*, K.
wasumaweeseek *April ; June ; September*, C. Said to mean "first sunny month." Cf. wäsemook.
watshoosooch *rain*, K. ; cf. bathic.
wáthik *arm*, C. wätheēkee *the whole arm*, K. ; cf. shedbasing.
Waunathoake, nom. pr. of Mary March (Howley).
wawashemet ŏ-ŏwin mŏŏ meshduck *we give you* (thee !) *a knife*, K.
weenoun *cheek*, K. ; cf. ge-oun.
weshomesh (Lloyd : washemesh) *herring ;* cf. wothamashet. Mr. Howley thinks that Washimish, the name of an island, contains this term.
whadicheme, cf. bogathōowytch.
widumite *to kiss.*
woadthoowin, woad-'hoowin *spider*, K.
woas-eeash, woas-eesh *Red Indian girl*, K.
woas-sut *Red Indian woman*, K. ; same as oosuck.
wobee *white*, K. ; cf. wabee.
wobesheet *sleeve*, K.
woin Howl.; waine *hoop.*

woodch *blackbird*, C.
woodum *pond*, K.
wothamashet Lloyd : *to run* ; woothyat *to walk.*
zathrook *husband ;* cf. anwoyding.
zeek *necklace*, K. ; abbr. from baasick (?)
zósoot K., zosweet *partridge.* Ptarmigan is added to the term; but a ptarmigan (*Lagopus alba*) is not a partridge.

Beothuk Song preserved by Cormack :

Sugut if bafu buth
baonsheen oōsadōōōsh edabauseek.

As there is no f in this language, the copying or the phonetics of this song must be partially faulty.

The Comet of 1866 and the Meteors of November 14th. By Professor Daniel Kirkwood.

(Read before the American Philosophical Society, July 17, 1885.)

The probable recognition of several ancient returns of the first comet of 1866, together with the identification of an additional number of star-showers related historically to this comet as their source; the further confirmation of the existence of three distinct meteoric clusters all moving in the orbit of Tempel's comet; and the data thus afforded for studying the structure and history of this interesting part of the solar system, afford sufficient reason for the following rediscussion of the facts now known in regard to the origin and history of the November meteors.

Tempel's Comet of 1866.

On the 19th of December, 1865, a small comet was discovered by M. Tempel, of Marseilles. It was generally observed till the following February; and, although an inconspicuous object, its relations to the earth and Uranus have given it an importance equaled by few comets recorded in history. It orbit was computed by Dr. Oppolzer, of Vienna, who found the time of revolution to be 33.176 years. Later researches, however, give 33.28 years as the more probable period. The comet seemed much smaller in 1865–6 than at any previously observed return—a fact indicative of its gradual dissolution. Its apparent magnitude, however, at any apparition, would evidently depend on the time of the year at which it passed its perihelion. Comets are recorded in the years 1733, 1699, and 1399, corresponding to dates at which Tempel's comet was [illegible]; but these returns are to be regarded as doubtful. In 1866 Professor H. A. Newton suggested that the comet of that year was a return of one discovered in China, August 26, 1336, and which passed its perihelion October

13th. This identity is now very generally admitted. The interval between the perihelion passages of 1366 and 1866 is 499.3 years ; or fifteen periods of 33.28 years. The comet of 1266 may have been a return of the same body ; the comet seen in China, September 29, 1133, was in all probability Tempel's ; the interval between the apparitions of 1133 and 1366 corresponding to seven periods of 33.28 years.

The comet seen in January, 868, both in China and Europe, has been regarded by Hind and others as an early appearance of Tempel's comet. "In 868," Mr. Hind remarks, "at the end of January, a comet was observed under the tail of Ursa Minor, which moved in seventeen days almost to the constellation Triangulum. In China it was seen in the first moon (February) with the same right ascension as stars in Aries and Musca. I find by calculation that when Tempel's comet arrives at perihelion at the end of March or early in April, it must follow this path in the heavens, being first situated at the end of January in the constellation Camelopardus, where, for want of conspicuous stars of reference, it might be said to be below the tail of Ursa Minor ; afterwards moving to Triangulum and Aries."* Neglecting the apparitions of 1133 and 1266 as perhaps more doubtful, the interval between 868 and 1366 is equal to fifteen periods of 33.24 years.

"Sometime between April and December, A.D. 69, a comet appeared."† The interval between this date and 868 is equal to twenty-four periods of 33.28 years. Seven periods of the same length take us back to B. C. 165 ; nine more, to B. C. 465 ; and two additional, to B. C. 531 ; at each of which epochs a comet is recorded. 465 B. C. is also the date at which the celebrated meteoric stone, called the "Mother of the Gods," was said to have fallen from the skies. The entire history includes 2396 years, or seventy two periods of 33.28 years.

The orbit of Tempel's comet approximately intersects that of the earth near perihelion and that of Uranus near aphelion. The discovery that it is intimately related to the meteors of November 14, and the fact that one of the minor clusters of these Leonids is soon to return, give interest to a new study of the recorded phenomena.

The Meteors of November 14th.

Professor H. A. Newton traced back the great showers of 1866 and 1833 to A. D. 902.‡ He showed that the period must be 180 days, 185 days, 355 days, 377 days, or 33.25 years, and even suggested the method of determining which of the five is the true period. This important problem was first solved, however, by Professor J. C. Adams, of England, who found the periodic time to be about 33.25 years.

The comet's perihelion passage occurred January 11, 1866. The meteoric shower derived from the principal group, A, was observed in Europe,

* Monthly Notices, Vol. xxxiii, p. 49.

† See Chambers' Catalogue, No. ii.

‡ Am. Journ. of Sci., May and July, 1864.

November 14, 1866, and the display was repeated with diminishing brilliancy in 1867, 1868, and 1869. The most dense part of the cluster passed the descending node of its orbit about November 13, 1833, and hence also early in 1867, or about a year after the comet passed the same point.

The conclusion that Tempel's comet and the great meteoric cluster of 1833 move in the same orbit, and that the latter was in fact derived from the former, was reached almost simultaneously by Peters, Leverrier, and Schiaparelli. In 1875 the present writer called attention to the fact that the dates of several meteoric showers given by Humboldt and Quetelet as belonging to the November stream, indicated the existence of a second cluster, B, moving in very nearly the same orbit. These, with the writer's observations in 1852, are as follows:

A. D. 288, 28 September, apparition in China.
855, 856, 21 October each year. For particulars, see Quetelet's Physique du Globe.
1787, "On the night between the 9th and 10th of November, many falling stars were observed at Manheim by Hemmer."
1818, 12 and 13 of November.
1820, 12 November.
1822, 12 November.
1823, 12 and 13 November.
1852, 13 November. Nature, 3 June, 1875.

The best observed seem to have been those of 288 and 1787. The interval, 1499 years, is equal to forty-five periods of 33.31 years. Seventeen of these periods bring us to A. D. 855. One period from 1787.86 brings us to 1821, the middle of the series 1818–1823. Another period would give 1854 as the time for the next display, the beginning of which was seen by the writer in 1852, when seventy-five meteors were counted between two and three o'clock. The next shower from this cluster will be due about November 13–15, 1887; the display, perhaps, commencing in 1886, or even in 1885.

The third cluster, C, has been less observed and is probably less extensive as well as less dense. The dates at which the shower has been observed are as follows:

A. D. 585, October 23 (O. S.). Quetelet's Catalogue.
1582, November 7. Quetelet's Catalogue.
1813, November 8. Cosmos, iv, p. 582.
1846, November 13. Ib., p. 578.
1847, November 13. Quetelet.
1849, November 13. Quetelet.
1879, November 14. Observatory, Dec., 1879, p. 248, and Jan., 1880, p. 274.
1880, November 14. Pop. Sci. Monthly, Feb. 1881, p. 542.

The phenomenon of 1813 was the most brilliant of this series observed in recent times. The interval between 585 and 1813 is 1228 years, or thirty-seven periods of 33.19 years; and the whole series of phenomena are represented as follows:

From 585 to 1582	. . . 997 y =	30 periods of	33.23	years.
1582 to 1813	. . . 231 y =	7 "	33.00	"
1813 to 1847	. . . 33.19 =	1 period of	33.19	"
1847 to 1880	. . . 33.19 =	1 "	33.19	"

The observed shower of 1582 was probably near the close of the cluster's passage across the earth's orbit. Thirty times the mean period of 33.19 years gives the epoch 1581.56, and the remaining dates are then perfectly harmonized.

The respective periods of the comet and the three meteoric groups are as follows:

Tempel's comet	33.28	years.
Group A (Newton)	33.25	"
Group B	33.31	"
Group C	33.19	"

During the last five hundred years the period of Group A seems to have been rather more than 33.25 years. The meteoric display of 1366 was contemporaneous, or nearly so, with the apparition of the comet, and the complete separation of this cluster from the original mass may have then occurred. "The comet of 1866 was invisible to the naked eye; that of 1366, seen under similar circumstances, was a conspicuous object. The statement of the Chinese historian that 'it appeared nearly as large as a tow measure,' though somewhat indefinite, certainly justifies the conclusion that its magnitude has greatly diminished during the last 500 years."* Is the less apparent magnitude a consequence of separation at that epoch?

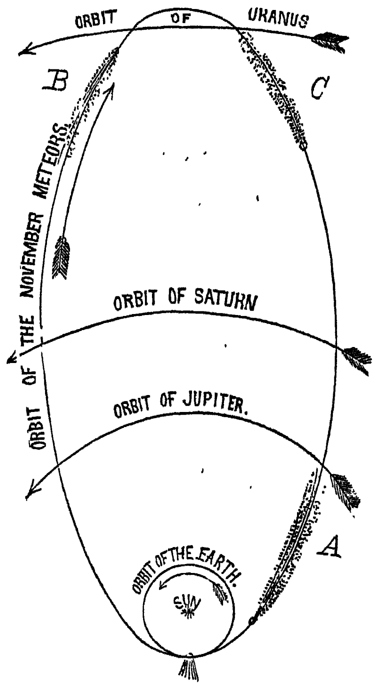
The following table affords the means of comparing the elements of the comet and those of the principal meteoric group:

	Nov. Meteors.	Tempel's Comet.
Perihelion passage	Nov. 10, 1866.	Jan. 11, 1866.
Longitude of perihelion	56° 26′	60° 28′
Long. of ascending node	231° 28′	231° 26′
Inclination	17° 44′	17° 18′
Perihelion distance	0.9878	0.9765
Eccentricity	0.9046	0.9054
Semi-major axis	10.3400	10.3240
Period	33.2500 y.	33.1760 y.
Motion	Retrograde.	Retrograde.
Computer	Schiaparelli.	Oppolzer.

The orbit of Tempel's comet and of the meteors associated with it is

* Comets and Meteors, p. 52.

represented in the following figure, where the relative positions of the meteoric clusters correspond to the epoch of the comet's perihelion passage in 1866:



The next returns of these several bodies may be expected at the times indicated below:

Tempel's comet	1899
Group A	1899 to 1901
Group B	1886 to 1889
Group C	1912 to 1915

This cometary and meteoric orbit is a connecting link between the orbits of the earth and Uranus; the perihelion being immediately within the former, and the aphelion just exterior to the latter. All matter moving in it is liable to considerable perturbation by Uranus and the earth, but each of the meteoric clusters is now too extensive to be much disturbed as a whole. The present writer has elsewhere noticed that about 547 B.C., just before the first recorded (probable) appearance of Tempel's comet, this body and Uranus were comparatively near each other.*

* Comets and Meteors, p. 80.

Stated Meeting, May 1, 1885.

Present, 5 members.

Mr. J. BLODGETT BRITTON in the Chair.

Donations for the Library were received from the Geological Survey of India; the Department of Mines at Melbourne; the Royal Society of Tasmania; the Société Impériale Russe de Geographie; the Anthropologische Gesellschaft in Wien; the K. Statistisch-Topographische Bureau at Stuttgart; the Naturforschende Gesellschaft at Emden; Dr. vom Rath of Bonn; the Statistika Central Byrån; the Reale Accademia dei Lincei at Rome; the Società Toscana di Scienze Naturali in Pisa; the Société de Geographie at Paris; Maisonneuve Frères of Paris; the Royal Astronomical Society, the Cobden Club, and Nature, London; Mr. F. J. R. Carulla of Swansea; the Boston Society of Natural History; the American Academy of Arts and Sciences; Mr. R. C. Winthrop, Jr., of Boston; Prof. Edward C. Pickering of Cambridge; the Rhode Island Historical Society; Dr. Henry Draper of New Haven; the Scientific Association at Meriden, Conn.; the New York Meteorological Observatory; the University of the State of New York; the Albany Institute; the Brooklyn Entomological Society; the Buffalo Historical Society; Mr. T. H. Dudley of Camden; the Franklin Institute; the Engineers' Club, the University of Pennsylvania, the American Naturalist, Mr. Henry Phillips, Jr., and Prof. E. D. Cope, of Philadelphia; the Department of the Interior, and the Oficina Meteorológica Argentina.

Letters of envoy were read from the Naturforschende Gesellschaft, Emden; Albany Institute; Department of State, Washington, D. C.; U. S. Geological Survey, Washington, D. C.; Geological Survey of India.

Letters of acknowledgment were read from the Cincinnati Society of Natural History (100–117); Observatorio Meteorólogico Central, Mexico (115); Royal Society of New South

Wales, Sydney (112–115); U. S. Naval Observatory, Washington (116); Ratcliffe Observatory (116); K. Baier. Akad. der Wissenschaften (114, 115).

Letters were read from Mr. William Sellers accepting the appointment to prepare an obituary notice of the late George Whitney; from Dr. Da Costa requesting to be excused from preparing an obituary notice of the late Dr. Ellerslie Wallace; on motion the Society excused Dr. Da Costa.

Mr. Philip H. Law read by appointment an obituary notice of the late William S. Vaux.

Dr. Harrison Allen made a communication on the construction of the foot in mammals, more especially in relation to the *tarsus* of the bat, as observed by himself under the microscope.

Pending nominations Nos. 1049 to 1054, and new nominations Nos. 1055, 1056 and 1057 were read.

The rough minutes were read and the Society was adjourned by the presiding member.

Stated Meeting, May 15, 1885.

Present, 10 members.

President, Mr. FRALEY, in the Chair.

Dr. James C. Wilson, a newly elected member, was presented to the Chair and took his seat.

Donations for the Library were received from the Imperial Academy of Sciences at St. Petersburg; Dr. Hugo Von Meltzel of Kolozsvar; Prof. Dr. G. D. E. Weyer of Kiel; the Reale Accademia dei Lincei at Rome; the Academie Royale des Sciences de Belgique; the Société de Geographie and L'Alliance Scientifique Universelle at Paris; the Meteorological Office, the Journal of Forestry, Nature, Dr. John Evans, Dr. William Huggins and Dr. Benjamin Ward Richardson, of London; the Boston Society of Natural History; the

Free Public Library of New Bedford; the Providence Public Library; the American Chemical Society and Mr. C. S. Sargent of New York; Mr. John B. Smith of Brooklyn; the Academy of Natural Sciences, the American Journal of Pharmacy, the Zoölogical Society, Mr. Henry Phillips, Jr., and Mr. R. S. Culin, of Philadelphia; the American Chemical Journal; Johns Hopkins University; the Bureau of Education; the Department of State at Washington, and the Kansas Academy of Sciences.

Letters of acknowledgment for Proceedings No. 118 were received from the Wyoming Historical and Geological Society (Wilkes-Barrè, Pa.); American Antiquarian Society (Worcester, Mass.); the Numismatic and Antiquarian Society of Philadelphia; the Maine, Rhode Island, New Hampshire, Connecticut, New Jersey, Maryland, Georgia, Wisconsin and Chicago Historical Societies; Museum of Comparative Zoölogy (Cambridge, Mass.); University of the City of New York (New York); Cincinnati Observatory (Cincinnati, Ohio); U. S. Military Academy (West Point, N. Y.); Essex Institute (Salem, Mass.); Prof. J. J. Stevenson, Prof. James W. Moore, Mr. Henry Phillips, Jr., Prof. Henry S. Frieze.

A letter of acknowledgment was received from Rawson W. Rawson (London), for Proceedings Nos. 95 to 116.

A letter was received from the Naturforschende Gesellschaft zu Freiburg i. Baden asking for No. 115 Proceedings.

A letter was received from Mr. William Blasius announcing a change of address to 916 Arch St., Phila.

Letters of envoy were read from the Public Library of Providence (R. I.), U. S. Geological Survey, U. S. Department of State.

A letter was read from Mr. Herbert Spencer (London), declining membership on grounds held sufficient by the Society.

Letters were read from the California Academy of Sciences and the Virginia Historical Society, requesting exchanges. On motion the matter was referred to the Secretaries with power to act.

Prof. H. Carvill Lewis read a communication entitled "A

great Trap Dyke across Southeastern Pennsylvania," to be accompanied by a map, not to cost over $25.

Permission was given the Secretaries to have a plate prepared at an estimated cost of not over $30 for Prof. Cope's paper on the Palæontology of Brazil (read April 17, 1885).

The President reported that he had appointed Prof. W. H. Pancoast to prepare an obituary notice of the late Prof. Ellerslie Wallace, and that as yet no person had accepted the same duty for the late Titian R. Peale.

The proceedings of the officers and Council were submitted.

Nominations Nos. 1049–1057, and new nominations Nos. 1057–1068, were read.

The rough minutes were read and the Society was adjourned by the President.

Stated Meeting, June 19, 1885.

Present, 13 members.

President, Mr. Fraley, in the Chair.

Mr. Samuel Wagner, a newly elected member, was presented to the Chair and took his seat.

Donations for the Library were received from the Physikalische Central-Observatorium at St. Petersburg; the Societas pro Fauna et Flora Fennica at Helsingfors; the K. B. Akademie der Wissenschaften and the Münchener Sternwarte; the K. K. Geologische Reichsanstalt; the Zoologischer Anzeiger, Leipzig, the R. P. Akademie der Wissenschaften and the Deutsche Geologische Gesellschaft at Berlin; the K. Gesellschaft der Wissenschaften at Göttingen; the Société de Physique et d'Histoire Naturelle at Geneva; the Musée Royale d'Histoire Naturelle de Belgique; the R. Accademia dei Lincei; the Società Toscana di Scienze Naturali; the Société de Geographie at Paris; the Royal Geographical and Astronomical Societies and Nature, London; the Philosophical

Society at Cambridge; the Royal Geological Society of Cornwall; the Nova Scotian Institute; the Boston Society of Natural History; the Essex Institute; the Rhode Island Society for the Encouragement of Domestic Industry; the American Journal of Science; the Academy of Sciences, the Meteorological Observatory and Prof. John S. Newberry of New York; the Brooklyn Library; Mr. John B. Smith of Brooklyn; the Franklin Institute, the Historical Society of Pennsylvania, the Pharmaceutical Association, the Mercantile Library, the American Naturalist, Mr. Henry Phillips, Jr., and the Misses Phillips of Philadelphia; the American Journal of Philology, Baltimore; the United States National Museum; the Virginia Historical Society; Mr. Jed. Hotchkiss of Staunton; the Public Library of Cincinnati; the Brookville Society of Natural History; Rev. Stephen D. Peet of Chicago; the State Historical Society of Iowa; the California Academy of Sciences; and the Observatorio Nacional Argentino.

Letters of envoy were received from La Société de Physique et d'Histoire Naturelle de Genêve, Yorkshire Geological and Polytechnic Society (Chevinedge, Halifax, England); Cambridge Philosophical Society; Engineers' Club (Philadelphia); Virginia Historical Society.

On motion the latter Society was placed upon the exchange list and ordered to receive the Society's Proceedings from No. 96.

Letters of acknowledgment were received from La Société de Physique et d'Histoire Naturelle de Genêve (Trans. XVI. i., Proceedings 109–114); Academie Royale Danoise des Sciences et des Lettres, Copenhagen (Trans. XVI. i., Proceedings 113, 114); Library of the University of Cambridge (116); Statistical Society of London (116); U. S. Geological Survey (117, 118); U. S. Surgeon General's Office (117, 118); the Smithsonian Institution (117, 118); Trübner & Co. (118); London Zoölogical Society (Proceedings 112, 113, 114, 115, 116; Trans. XVI., i.); Philosophical Society of West Chester (118); Kansas State Historical Society (118); Leander McCormick Observatory, University of Virginia (118, 119).

Letters of acknowledgment for Proceedings No. 119 were read from the Maine, Connecticut, New Hampshire, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, Georgia, Kansas State, Wisconsin and Chicago Historical Societies; New Bedford Free Public Library; U. S. Surgeon-General's Office (Washington, D.C.); University of California (Berkeley, Cal.); Philosophical Society of West Chester (Pa.); Brown University (Providence, R. I.); American Antiquarian Society; Boston Athenæum; Astor Library (New York City, N. Y.); Essex Institute; Numismatic and Antiquarian Society of Philadelphia; Wyoming Historical and Geological Society (Wilkes-Barrè, Pa.); Young Men's Library (Buffalo, N. Y.); University of the City of New York (New York); Entomological Society of Brooklyn (N. Y.); Library U. S. Military Academy (West Point, N. Y.); Library of the State of New York (Albany, N. Y.); Cincinnati Observatory; Rantoul Literary Society; U. S. Naval Institute (Annapolis, Md.); College of Physicians (Philadelphia); Library Company of Philadelphia; Smithsonian Institution; Prof. J. W. Moore (Easton, Pa.); Henry Phillips, Jr. (Philadelphia); Dr. W. S. W. Ruschenberger (Philadelphia); Wm. B. Taylor (Washington, D. C.); J. J. Stevenson.

The death of Robert Treat Paine of Brookline, Mass., was announced as having occurred June 3, 1885 (born October 12, 1804).

On motion the President was authorized to appoint, if he saw fit, a proper person to prepare the usual obituary notice.

The death of Prof. Thos. C. Archer, of Edinburgh, was announced.

Dr. Harrison Allen presented for the Transactions a paper by Dr. J. Francis Walsh on the anatomy and functions of the muscles of the hand and of the extensor tendons of the thumb, which was upon motion referred to Dr. Brinton, Dr. Ruschenberger and Dr. Leidy to examine and report upon.

Dr. A. S. Gatschet presented a paper on the Beothuk Indians, with a vocabulary.

Professor Cope presented a paper entitled "A Second Con-

tinuation of Researches among the Batrachia of the Coal Regions of Ohio."

Prof. Cope presented a paper by Dr. Alfred C. Stokes of Trenton, N. J., on some new hypotrichnous infusoria.

Pending nominations Nos. 1049–1068 were read.

On motion the Society subscribed to the Monthly Catalogue of the Publications of the United States Government, issued by Jno. H. Hickcox, of Washington.

On motion the Treasurer was authorized to receive ten thousand dollars six per cent loan of the City of Philadelphia, which will fall due on July 1, 1885.

Prof. Cope requested permission to add some new matter to his paper on Mexican Zoölogy (read April 17, 1885), which was now in press.

Mr. McKean offered the following resolution, which was unanimously adopted:

Resolved, That the Society permit Prof. Cope to make the additions to the paper as requested by him; but that hereafter when material changes shall be proposed to a paper already ordered to be printed in the Proceedings, the proposed changes or additions shall first be submitted to the Secretaries, and it shall be in the discretion of the Secretaries either to admit or exclude the changes or ask the advice of the Society thereon.

At the suggestion of the President, and on motion of Mr. Phillips, it was resolved that the Committee on Publication be requested to take into consideration the present system of publishing the Proceedings and Transactions of the Society and to report what it believed would be the best mode of publication and issue, and what changes if any in the present method are desirable.

The rough minutes were read and the Society was adjourned by the President.

Stated Meeting, July 17, 1885.

Present, 4 members.

President, Mr. FRALEY, in the Chair.

Donations for the Library were received from the New Zealand Institute; the Geological Survey of India; the K. K. Geographische Gesellschaft at Wien; the Naturwissenschaftlicher Verein at Bremen; the Naturforschende Gesellschaft at Görlitz and Emden; the Naturhistorischer Verein der Preussischen Rheinlande und Westphalens at Bonn; the University of Lund; the Statistika Central Byrån at Stockholm; the Naturwissenschaftliche Gesellschaft at St. Gallen; Société Vaudoise des Sciences Naturelles at Lausanne; the Société Royale des Antiquaires du Nord and L'Académie Royale at Copenhagen; the Société Hollandaise des Sciences at Haarlem; the Bataviaasche Genootschap van Kunsten en Wetenschappen; the Académie Royale de Belgique; the Reale Accademia dei Lincei at Rome; the Société d'Anthropologie, les Sociétés Geologique, Zoologique, École Polytechnique, Musée d'Histoire Naturelle, Bureau des Longitudes, Annales des Mines, Ministère de l'Instruction Publique et des Beaux Arts, and the Observatoire de Paris; the Musée Guimet; the Real Academia de la Historia at Madrid; the London Geological, Zoölogical, Royal Geographical, Meteorological, Astronomical Societies, the Meteorological Office, Royal Asiatic Society of Great Britain and Ireland; the British Association for the Advancement of Science; Nature and Prof. Joseph Prestwich of London; the Geological and Polytechnical Society of the West Riding of Yorkshire; the Royal Dublin Society; Mr. Thomas D. Smellie of Glasgow; the Royal Society and the Geological and Natural History Survey of Canada; the New Hampshire Historical Society; Mr. Amos Perry of Providence, R. I.; the American Oriental Society and the American Journal of Science, New Haven; Yale College; the New York Meteorological Observatory; Mr. John B. Smith of Brooklyn; the Geological Survey

of New Jersey; the Engineers' Club of Philadelphia; the Franklin Institute; the American Journal of the Medical Sciences; the College of Pharmacy; the Historical Society of Pennsylvania; the Philadelphia Library; the American Naturalist; the Children's Aid Society; Dr. Persifor Frazer, Messrs. Samuel H. Scudder, Henry Phillips, Jr., S. Culin and Samuel W. Pennypacker of Philadelphia; the Wyoming Historical and Geological Society; the Second Geological Survey of Pennsylvania; the United States Naval Institute; the Maryland Historical Society; the Peabody Institute; the Johns Hopkins University; the Department of State; the United States Civil Service Commission; the War Department; the United States National Museum; the Department of the Interior; the United States Geological Survey; Mr. Jed. Hotchkiss of Staunton, Va.; Mr. R. A. Brock of Richmond; the Des Moines Academy of Science; the University of California; the California Academy of Natural Sciences, and Mr. Ramon Manterola of Mexico.

Mr. Henry Phillips, Jr., deposited in the Library the Transactions of the Royal Historical Society (London).

Letters of envoy were received from the California Academy of Sciences; Société Hollandaise des Sciences, Haarlem; Université Royale de Lund; U. S. Geological Survey, Washington, D.C.; Naturforschende Gesellschaft zu Görlitz; Naturforschende Gesellschaft in Emden; Royal Society of Canada; Department of Internal Affairs, Harrisburg, Pa.

Letters of acknowledgment were read from the Virginia Historical Society (96–119); Natural History Museum, Strassburg (116); Kansas State Historical Society (119); Université Royale de Lund (116).

The Committee appointed to examine the paper presented for the Transactions at the last meeting by Dr. Walsh, reported it undesirable for publication by the Society.

On motion the report was accepted and the Committee discharged.

The deaths of the following members were announced:

Dr. Franklin B. Hough, Lowville, N. Y., June 11, 1885, æt. 63.

Dr. Edward B. Hartshorne, Philadelphia, June 22, 1885, æt. 68.

Lieut. Henry H. Gorringe, New York, N. Y., July 6, 1885.

On motion the President was authorized at his discretion to appoint suitable persons to prepare the usual obituary notices.

The President reported that he had appointed Samuel Wagner, Esq., to prepare an obituary notice of the late Robert Treat Paine, and that Mr. Wagner had accepted the duty.

A paper by Prof. Daniel Kirkwood of Bloomington, Indiana, entitled "The Comet of 1866, and the Meteors of November 14th," was presented, for which a plate was authorized.

Pending nominations Nos. 1049–1068 were read.

On motion the Society ordered, subject to the approval of the Finance Committee, that a plate should be prepared to accompany Dr. Stokes' paper presented at the last meeting at a total cost not to exceed $44.

On motion the Society resolved to dispense with the meetings of August 21st and September 18th, and with that of the Officers and Council on August 14th.

The rough minutes were read and the Society was adjourned by the President.

A great Trap Dyke across Southeastern Pennsylvania. By Prof. H. Carvill Lewis.

(Read before the American Philosophical Society, May 15, 1885.)

Prof. H. D. Rogers, in his Report on the Geology of Pennsylvania, published in 1858, refers to two trap dykes in Southeastern Pennsylvania. One of these is said to cross the Bethlehem turnpike about a mile above Flourtown, being "about two and one-half miles long, commencing north-west of Springfield township and ranging past Bickell's Mill on the Wissahickon to the School-House further west." * The other dyke is described as follows: "Another dyke or trap crosses the Schuylkill near Conshohocken; commencing a little east of the Perkiomen turnpike, about half way between Barren Hill and Marble Hall, it crosses the Norristown or Ridge turnpike, ranges nearly along the crest of the Conshohocken

* Geol. of Penna., Rogers, Vol. 1, p. 214, 1858.

slate ridge, goes through the village, and passing the river, in the bed of which it may be seen, it follows the summit of Bethel hill into Delaware county, terminating near the road leading from the Lancaster turnpike to the King of Prussia village. This is by far the longest and widest trap dyke of the valley or its borders, its length being a little more than six miles."*

In the map published by the Second Geological Survey, under the direction of Prof. J. P. Lesley, Mr. C. E. Hall has connected the two dykes on Prof. Rogers' map to form a single dyke extending from the east of Flourtown in a west, south-westerly direction to the borders of Delaware county. In his report (C^6), Mr. Hall refers to the dyke briefly in several places. He says (p. 19), that "it extends in a nearly straight line from the county line south-west of Mechanicsville, a short distance north of Gulf creek, to Flourtown in Springfield township. East of Flourtown it has not been traced continuously. There are exposures of loose blocks of trap, however, in several localities extending in a north-east direction from the last exposures of the main belt at Flourtown."

He gives, on p. 23, a map showing some isolated exposures of trap boulders in Upper Dublin township, which indicate the probable north-west continuation of the dyke.

He makes some apparently irreconcilable statements as to whether or not it occupies a line of fault or disturbance. Thus. while saying (p. 20), "The dyke does not seem to mark any line of disturbance. It may occupy a fissure crack, along which no lateral movement has taken place;" he says on p. 75: "This dyke, evidently located along the line of some disturbance, is undoubtedly the course of a fault or fracture. There is, however, no positive proof of any lateral movement."

Mr. Hall represents the dyke on the colored map accompanying his report as having a length of a fraction over eight miles.

In the present paper, which is the result of the personal observations of the writer, made during the past two years, it will be shown, that the dyke heretofore described is only a small portion of a long narrow dyke which passes almost entirely across the south-eastern corner of this State, from near Doylestown to Maryland, and which, taken together with some parallel dykes of similar nature and composition, north-east of Doylestown, forms a series of nearly continuous dykes some ninety miles in length.

It will be shown that a great fissure was made at the close of the Triassic period across the State, which fissure, filled by eruptive diabase, traverses strata of Laurentian, Cambrian, Silurian and Triassic age in an almost unbroken line, thus becoming an important feature in the geology of the State.

We shall follow it continuously from a fine exposure south of Doylestown along its south-west course through Bucks, Montgomery, Delaware and Chester counties, to the Maryland border, and shall demonstrate by a detailed list of its outcrops, that, although frequently represented only by

* Geol. of Penna., Rogers, Vol. 1, p. 214, 1858.

a line of loose weathered boulders, it is practically continuous along a line seventy miles in length.

It will be shown that in Bucks county, the dyke abuts against the south side of a great fault of several thousand feet upthrow, and upwards of twenty miles in length, and that, at a distance laterally of five miles, another long dyke of identical composition and structure, as proved both chemically and microscopically, abuts against the north side of the fault, continuing thence to the Delaware river. If not the same dyke laterally displaced, the two portions clearly belong to the same system, produced by a single cause.

The following description of the course of the dyke south-westward from the Neshaminy creek, near Doylestown, is supplemented by an accompanying map in which all the observed outcrops are plotted.

The dyke forms a very prominent hill at the north end of what is known as "Mundock ridge," at a point one mile south-east of the village of Bridgepoint. The Neshaminy creek flows at its base, and the trap forms a conspicuous hill, steep on the north side, from the top of which there is a view of Doylestown and vicinity. This is at the corner of Warminster, Doylestown and Warwick townships.

As nearly as can be ascertained the dyke is here about 100 feet wide. It is a fine grained diabase (dolerite), finely crystalline, and, as shown by the microscope, composed of lath-shaped crystals of plagioclase, enclosing irregular grains of augite and grains and crystals of magnetite. It rings like metal when struck, and covers the hillside with large fragments, generally well rounded by the process of concentric weathering, due to atmospheric influences, and often much rusted on the outside.

The dyke rises in the middle of the Triassic area, cutting through the upper Triassic shales. It is clearly therefore of late or Post-Triassic age.

The Triassic shales and sandstones, immediately adjacent to the dyke, are not altered by it. Yet, in the vicinity, northward from the dyke and about Bridgepoint, the shales are strongly baked and blackened, breaking with conchoidal fracture and ringing when struck. They somewhat resemble, when so altered, a black limestone.

These baked shales, however, cannot be proved to have any connection with the dyke, as will be more definitely shown when we consider the great fault against which the dyke here abuts. They seem to be, however, connected with the fault, since all along it, for many miles, these baked rocks occur, as if heat had been evolved during the faulting. On the other hand, no local metamorphic effects have as yet been observed anywhere along the sides of the dyke. The molten trap seems to have cooled too rapidly to produce such effects.

The dyke was followed from this point in a direction to west of south, and was noticed as it crosses each road in the eastern corner of Warrington township, passing a half mile east of Warrington P. O., forming the "Mundock ridge." In Bucks and Montgomery counties the term "mundock" is universally given to the trap. The trap runs at first nearly due

south, crossing the Little Neshaminy creek near the line between Warminster and Warrington townships, and in Warminster township gradually bending south-westward till it crosses the county line into *Montgomery county* a mile and a half west of Warminster P. O.

In Horsham township, Montgomery county, it passes through the upper part of the village of Horshamville, crossing the Doylestown pike at the tollgate. It crosses the Welsh road 100 ft. above the road leading from Horshamville to Jarrettown, here forming a sharp hill. It is traced continuously from here to Jarrettown, where it runs under the school-house and the Methodist Church. The ground is covered with boulders of trap, giving the impression that the dyke is wide at this point. It here forms a sharp hill, descending steeply to the north. A white Triassic sandstone outcrops south of the dyke, between Jarrettown and Dreshertown.

A road running south-west from Jarrettown keeps along the dyke, which for some miles forms a steep slope on its north side, and is readily recognized. It crosses Susquehanna avenue about 100 ft. north of the road from Jarrettown, and is conspicuous at the crossing of a small creek half a mile further south-west.

It is now approaching the edge of the Triassic formation, and in the course of half a mile enters the Lower Silurian limestone valley of White Marsh. "Mundock Hill," is a prominent feature on the Township Line road at the fork of the roads at the corner of Springfield, White Marsh and Upper Dublin townships. The fragments of trap are here sometimes five feet in length, and cover the side of the hill, extending down the Township Line road as far as Sandy run.

Thus far the dyke has been followed without break in its course. Just here, however, at the corner of the three townships, there appears to be a break of a few hundred feet, since no boulders of trap were noticed on the road immediately west of the North Pennsylvania Railroad near Sandy Run station. It may be that, the ground in the limestone valley now entered being highly cultivated, the boulders have been removed by man, and that the break is more apparent than real. For on the next road westward, Church road, the dyke is clearly shown by numerous boulders at the junction of the road to Flourtown.

The dyke has now entered the Lower Silurian (Calciferous, Chazy and Trenton) limestones of White Marsh valley, and cuts through them successively without any apparent alteration either in the dip or in the character of the limestones. No evidence that the dyke was a line of fault could be detected. The trap dyke continues across Springfield township through Flourtown, as observed by Prof. Rogers and Mr. Hall, to the Wissahickon creek, which it crosses at a point one-half mile north of the Philadelphia county line. It here outcrops as a distinct wall sharply rising out of the soil. It crosses a field in the stock farm recently owned by A. Welch, and is well marked on the creek. It here offers an instructive example of a typical dyke. From here to Marble Hall, where there is probably a small "jog" in its course, it is well marked as a line of

boulders. It appears near the marble quarry, and trends across White Marsh township in a straight line in a west south-west direction toward Spring Mill, being recognized by its boulders at each road crossed.

These boulders, where not washed by streams, are decomposed on the surface, and are continually becoming smaller as time goes on. On high ground, where the soil is much decomposed, the dyke is only traceable with difficulty. On the hill east of Spring Mill, half a mile from the Schuylkill river, where numerous trap boulders, covered by a crust of soft brown oxidized material, occur on the roadside, large numbers of them were observed to be covered with peculiar markings or striæ. The soft crust was marked by grooves each nearly a quarter of an inch in depth, and running from the angular edges of the boulders in somewhat parallel directions, one set of scratches often crossing another. Two rude sketches of these curious markings are here given, having been taken by the author in the Spring of 1879 :

These markings, which are common on fine grained ferruginous trap, and may be a foot or more in length, have been mistaken for glacial striæ by several writers. Thus one writer,* after describing the scoring and scratching of the boulders in Warrington township, Bucks county, says that they "evidently mark the progress of a glacier, and cannot otherwise be accounted for." Similar mistakes have been made in Chester county.† Even such a well known geologist as Rev. H. W. Crosskey, LL.D., F.G.S.,‡ of Birmingham, has described and figured markings of this character in decomposed trap boulders in Worcestershire, England, as true glacial striæ. The excellent plates and the detailed description he has published, show the markings to be identical with those on the trap now under description, which are quite different from true glacial striæ. In fact, they are, in all probability, *plough marks*. They are precisely such as would be formed by the sharp point of a plough passing over the decomposed surface of a trap boulder. As would be expected, they generally occur only on one side of any boulder, the side uppermost, when ploughing was going on. As shown by the author, in his report on the Terminal Moraine§, and more particularly in a recent paper,‖ they are far south of the limits of glaciation.

* History of Bucks County. Davis, p. 438.

† History of Chester County. Smith and Futhey, p. 186.

‡ The Grooved Blocks and Boulder clays of Rowley Hill. Proc. Birm. Philos. Soc., Vol. iii, 1882, p. 459.

§ Report Second Geolog. Survey of Pennsylvania, Z.

‖ On Supposed Glaciation in Pennsylvania, south of the Terminal Moraine. Lewis. Amer. Journ. Science, Arts, xxviii, 1884, p. 276.

An interesting exposure of the trap in place was noticed at a short distance north of the spring, at Spring Mill, where the dyke is cut through by the creek. This is the only locality in Pennsylvania where the author has observed *basaltic* or *columnar structure* in this dyke. Large columns of trap lie here, nearly horizontally, several of them showing six sides, and one of them five feet in diameter. Their nearly horizontal position is, of course, due to the fact, that the columns lie at right angles to the cooling surfaces. As the cooling surfaces are here nearly perpendicular, the columns have taken a horizontal position. The columns appear to have an inclination of about eight degrees to the horizon, indicating, perhaps, that the dyke varies that much from the perpendicular. Although columnar structure has not been noticed elsewhere in this dyke, another structure characteristic of eruptive rocks is seen everywhere along the whole line. *Concretionary* structure, which, sometimes associated with columnar structure, but oftener observed alone, is due to the same contraction of the cooling mass, which sometimes forms columns, is a very common feature of the dyke. Though not apparent in the fresh rock, this structure is readily seen during the process of weathering, producing, finally, the rounded boulders that have already been described.

At Conshohocken, the dyke is finely exposed in the town and forms a conspicuous escarpment on the river bank, well seen from the railroad. At the time that the new Schuylkill Valley Railroad was being built, much was said about the difficulty experienced by the contractors in cutting through this remarkably tough rock at Conshohocken.

Crossing the Schuylkill, in the bed of which it is seen, as described by Professor Rogers, and being well shown on the west side of the river where cut through by the Philadelphia and Reading Railroad in West Conshohocken, the dyke follows a long straight line through Lower Merion township, Montgomery county, as mapped in Report C^6, Second Geological Survey. It is well shown near Mechanicsville, where cut through by Gulf creek. In this portion of its course the dyke either cuts through or runs along the southern boundary of the hydromica schists (Hudson River Age?) of the South Valley hill. A few hundred feet west of Mechanicsville, it is in contact with highly metamorphic limestone, a continuation of that which occurs in Cream valley.

Immediately west of here, at the head waters of Gulf creek, it is in contact with what appears to be lower Cambrian sandstone, here highly altered into a slaty rock ringing like metal when struck. The strata stand nearly perpendicular with a steep north dip, and are much altered. The metamorphism is believed by the author to be of much more ancient date than the time of the eruption of this trap.

After crossing the stream, it enters *Delaware county*, Radnor township, and crosses the Pennsylvania Railroad at a point about a quarter of a mile west of Wayne station (at mile-post 15–338). Numerous loose boulders occurred here in the soil, but have recently been removed for railroad ballast.

It is here in contact with "Edgehill Rock" (altered Potsdam). Ancient eruptive norite rocks occur at Wayne station, and the trap lies between these older rocks (generally supposed to be Laurentian) and the hydromica schists of the South Valley hill, which are entered by the railroad west of here.

The dyke enters Chester county in Easttown township, south of Devon Inn, where it is in the so-called Laurentian area, and it is well shown at the cross-roads at the corners of Easttown, Tredyffrin, and Radnor townships.

Many other eruptive rocks, in the form both of dykes and of large bosses, occur in the so-called Laurentian area, in the region south and west of here, being largely developed in Chester county. These rocks are now being studied microscopically by the author, who finds many of them to be of high interest and capable of throwing much light on the difficult geology of the region. The author has discovered an immense area of eruptive garnet-bearing acid norite, with included dykes of diorite, diabase, gabbro, trap-granulite, etc., and he has observed highly interesting effects of pressure, stretching and endomorphic changes. These will be described in a subsequent paper. They are mentioned here merely to state that these eruptive rocks have no possible connection with the much later dyke which forms the subject of this paper.

In Chester county the presence of trap along the southern border of the South Valley hill in connection with serpentine, was briefly noted by Rogers,* and Dr. P. Frazer in his report on Chester county† has mentioned a few isolated occurrences here and there, without, however, noting them on the map. The only portion of the dyke placed upon his map is in Easttown township, where, however, its line is not correctly represented.

An interesting feature of the great dyke in Chester county, are a number of small "jogs," which continually displace the dyke short distances to the northward. They are probably due to faults, since the same peculiar structure is noticeable in the dykes of serpentine in the same region.

Two such jogs are indicated in Easttown township; one of them, half a mile west of Devon Inn, the other somewhat more than a mile south-east of Paoli. The dyke ends south-west of Devon Inn, but appears again farther north on the road leading south from Reeseville, just south of an exposure of serpentine. It now runs south-westerly to the Sugartown road, at a point where the road forks southward to Leopard P. O. In this vicinity large boulders, often four to five feet in length, are scattered about on the soil, and are often resonant when struck. Again the trap makes a jog of about half a mile to the north, as though again faulted. Appearing in the north-west corner of Easttown township, on the road leading from Leopard P. O. to Howellville, south of the cross-road to Sugartown, it here divides the hydromica schists on the north side from the hard syenite and hornblendic rocks on the south side. The dyke keeps in this geological position between the two formations all the way from

* Geol. of Penna., i, p. 169.

† C4, Second Geol. Survey of Penna., pp.

here to the vicinity of West Chester, and in this part of its course may possibly occupy a line of fault. A series of serpentine outcrops occupy the same position, being sometimes north and sometimes south of the trap dyke, but nearly always adjacent to it, and generally south of it.

The dyke, containing here specks of pyrite, enters Willistown township, south of Paoli, and skirts the north side of the Serpentine belt. South of Malvern, at the northern edge of the Serpentine belt (about a quarter of a mile south of the State road), the dyke is represented by large and numerous boulders, and a much smaller dyke of trap appears near the southern edge of the Serpentine about one half mile south of the last place. Massive hornblendic rocks lie immediately south of this.

On the Township Line road between Willistown and East Goshen, close to the crossing of the State road, the trap occurs immediately north of the Serpentine ridge.

In East Goshen township it appears where the State road crosses Ridley creek, and continuing thence in a south-westerly direction, still keeping on the north side of the serpentine ridge, is broken by a small "jog" north of Goshenville. The displacement is only a few hundred feet. Small dykes of trap occur both on the north and south sides of the Serpentine ridge, one-half mile north-west from Goshenville. Thence the dyke passes into West Goshen township, crossing the road between East Goshen and West Goshen townships, near the house of J. Patterson, where it forms a prominent ridge, and the trap outcrops in large angular fragments on the roadside. Ancient gneisses lie south of the dyke and hydromica schists a short distance north of it.

In this township (West Goshen), it is clearly shown where crossed by the West Chester branch of the Pennsylvania Railroad, two miles north-east of West Chester. Here again it is on the north side of the serpentine ridge, or, as it is here called, the "Serpentine Barrens." Numerous boulders lie along the railroad, and the decomposed dyke is exposed in the carriage road alongside. It crosses the road leading from West Chester to Lionville, a short distance north of Taylor's run, south of the cemetery. Further west it appears in East Bradford township, one-eighth of a mile north of an outcrop of limestone, and is well shown were crossed by a branch of the Black Horse run. It was traced continuously by its boulders to the west branch of the Brandywine creek, at Copesville, on the Strasburg road. West of the Brandywine, where crossing the road, it forms rounded boulders, often perfectly oval in shape as though rounded by water action. These atmospheric boulders, produced by concentric weathering, might readily be mistaken for water-worn cobble-stones.

In West Bradford township, the dyke keeps south of the Strasburg road, and was noted when crossing each road. It passes a short distance south of Marshalton, and thence reaches the west branch of the Brandywine creek, one-half mile north-west of Trimbleville. Along its course one frequently sees walls, and even barns and houses built of the trap. The old Black Horse Tavern on the Strasburg road is built of it.

Immediately south of Marshalton, from which place north-eastward for nine miles the dyke has been perfectly straight and continuous, there is a slight bend, or perhaps a small jog in the dyke, as it bends slightly to the south. It is readily traced on all the roads in this vicinity.

In Newlin township the dyke is again associated with a belt of serpentine. Beginning just north-west of North Brook Station on the Wilmington and Reading Railroad, it runs into a serpentine belt, a mile or more in length, which lies north-east and south-west, and which is famous by reason of valuable corundum mines on its northern flank. The dyke apparently cuts through the center of the serpentine ridge. An altered granitic rock adjoins the serpentine, and contains a large number of interesting minerals associated with corundum. The latter occurs both massive and in crystals, and in masses more or less altered into damourite, etc.,* and appears to be of contemporaneous origin with the serpentine.

The trap dyke enters East Marlborough township, one-half mile north-east of Unionville, and passes immediately west of that village, being seen at the fork of the roads, under the bed of a small stream which forms the headwaters of Red Clay creek. Entering west Marlborough township near the village of Upland, large fragments of trap are seen, at the limestone quarries, west of Upland, on the State road. The line crosses the State road at the farm of B. Maule, one mile west of Upland, forming a distinct ridge.

South-west of here it is finely shown where crossing a north and south road one mile north-west of Woodville. It passes under the house of Mrs. Rebecca Levis, half a mile north of the Street road, and for some distance, the road runs along it affording a good exhibition of it. Huge boulders of diabase line the road and are built into the fences and into the walls.

Several small jogs apparently occur in the dyke in the vicinity of Upland. Such jogs are to be expected in a crack in the earth's crust of the length here described. From here, nearly to the Maryland border, however, the dyke appears to be perfectly continuous.

Continuing south-west, the dyke crosses the Pennsylvania and Delaware R. R., close to the crossing of the Street road, and entering London Grove township on the farm of Mifflin J. Baker, it here seems again to divide hornblendic and syenitic older gneisses from the micaceous schists and the quartzites which cover the country to the north-west. It crosses a small creek, the east branch of White Clay creek, south-west of here ; is well shown in a north and south road in a wood ; passes through the farm of J. Speakman and crosses the Gap and Newport turnpike, one-half mile east of the Londonderry township line.

Passing south-west across a farm once owned by P. McNelly, it reaches the middle branch of White Clay creek near the corner of Londonderry, Penn and London Grove townships.

In the high regions covered by decomposed schists south-west of here,

*See "Corundum, its alterations and associated minerals." F. A. Genth, Proc. Amer. Philos. Soc., Sept. 19, 1873, also Report B. Second Geol. Survey of Penna.

it was traced with difficulty. The rocks are decomposed to a depth of fifty feet or more, and the trap appears only where streams have lowered the surface.

Two local branches of the great dyke appeared in London Grove township. One of these crosses the Street road at Woodville, and the other crosses the same road about a quarter of a mile further west, just west of a small creek and on the west side of an exposure of south dipping mica schist.

These dykes can be traced across a north and south road just west of here. The one is marked by scattered boulders, only. The other and more southern of the two is exposed as a narrow dyke about a yard wide, cutting through a ridge made of decomposed gneiss, on the farm of S. H. Hoopes, one-half mile north-east of Chatham P. O.

In Penn township the dyke is marked by scattered boulders only; and the decomposition of the soil is so profound that great care was necessary in following, step by step, the true course of the dyke. It was found to enter the north-eastern corner of the township and, passing a mile and a half north of Jennersville, to go through the farms of J. Vandegrift, S. B. Reese, L. Mendenhall, D. Mackey, Sharlton, Underwood, Myers, Thos. Jackson and Matlock in a continuous south-western line. It passes a quarter of a mile north of Forrestville, where it is shown feebly by a few small boulders on the road side. It crosses the east branch of Big Elk creek, just below the bridge on the road from Jennersville to Russelville, where large fragments occur, some of them ringing like a bell. From here to its fine outcrop west of Lincoln University, it is traced with difficulty, being shown by scattered boulders only.

In Lower Oxford township the dyke is conspicuously shown one mile south-west of Lincoln University, just west of the west branch of the Big Elk creek. It here forms a marked ridge near the house of S. Massey, and is as finely shown as anywhere along this part of its course.

In the diabase at this place there is a soft chloritic mineral in nodules, and a little chalcopyrite.

About one mile south west from here, it is well shown where crossing a north and south road, near the entrance to Mrs. Flemings' farm, half-way between the railroad and the Oxford and Jennersville road.

Fragments five feet or more in length occur here. It runs past the house and reaches the Philadelphia and Baltimore Central R. R., at the meadow adjoining to the west the same house, being somewhat more than a mile west of Oxford station. Crossing the railroad, it enters East Nottingham township and runs through the farms of Mrs. Mercer and W. Pickering, thus just touching the borough of Oxford, though not getting within a mile of the railroad station at Oxford.

All through south-western Chester county the trap is known by the farmers under the name of "Cammels," "Carmels," or "Cammell stone." It is also sometimes called "Iron stone," from the rusty exterior.

"Cammells" appear on the farm of Benjamin Pickering, near Oxford,

and are shown abundantly at the house of James McFall in the adjoining woods, and on the road near a cross-road, at a small creek half a mile east of New Prospect. A large boulder of diabase, five feet long, lies opposite the house of J. Brown (formerly W. G. Hutchinson), and shows the approximate position of the dyke where crossing the main road south of New Prospect.

The trap is again well shown in the meadow of J. K. Newell (formerly Pollock), where crossing North-East creek at the boundaries of West Nottingham and East Nottingham townships. The dyke crosses the creek less than a mile south east of Nottingham P. O. From here southward, the trap boulders are known as "Niggerheads." In West Nottingham township the dyke once more enters a serpentine region and is here no longer well marked as a separate and distinct dyke. A number of outcrops of diabase occur in this serpentine region, as also a number of other eruptive rocks, including several coarse grained amphibolites and diorites of older geological age. At the chrome mine of Moro Phillips, opposite Pine Grove School-house, there is a small dyke of diabase some five feet wide, which is, perhaps, a branch of the long dyke. Numerous boulders and fragments of diabase occur at the crossing of the Baltimore Central Railroad by the first road north of the Maryland State line. On approaching the State Line Station coarse grained eruptive rocks appear, as also large masses of ligniform anthrophyllite; from here southward, in Maryland, numerous ancient amphibolites, gabbros, etc., occur, probably being of the same age as similar rocks in the vicinity of West Chester.

The dyke, probably, enters Maryland a little west of State Line Station (Penn Mar) on the Baltimore Central Railroad. It has not been traced beyond the borders of Pennsylvania.

Although of remarkable uniformity of texture and composition throughout the whole of its course, this long dyke has, as we have seen, received various local names. While the name "iron-stone" is probably most commonly applied to it, the trap boulders are called "mundocks" in Bucks and Montgomery counties, "camells" in Chester county, and "niggerheads" on approaching the Maryland border.

A curious bit of history, for the accuracy of which, however, the writer cannot vouch, may be introduced in this connection. It is said that the dyke was used during the late war of the Rebellion by the negro slaves as a guide in their flight northward. Several of the stations on the "Underground Railroad" are stated to have been on or near the line of this dyke. It is said that the negroes were directed to follow these black rocks across fields and through woods until they were led into the hospitable regions of Chester and Bucks counties.

Among the many features connected with this long dyke, are the metalliferous deposits which are due to it. Mention has been made of the pyrite or chalchopyrite sometimes observable to the naked eye, and of the crusts of iron oxide produced as the trap decomposes. The microscope also reveals an abundance of magnetite in the thin section. It is natural there-

fore that, at several points in Chester county, we find that iron ore has been dug adjacent to the dyke.

Thoughout the whole line, every feature of the dyke has been remarkably constant, and it is clearly to be regarded as a single dyke, interrupted only by occasional jogs. That these "jogs" are due to contemporaneous faulting will be rendered probable upon a consideration of the great fault in Bucks county, to the description of which we may now proceed.

It has long been surmised that a fault existed immediately south of the long, narrow strip of lower Silurian limestone, which suddenly appears in the midst of the Triassic area of Bucks county. This strip of limestone, extending in a south-west direction from Limeport on the Delaware to a point south-eastward of Doylestown, was briefly referred to by Professor Rogers, and has been mentioned by several geologists since, but never satisfactorily explained. While some thought that it was due to a fault, other geologists (Mr. C. E. Hall, etc.), supposed that it was an island in the Triassic sea, adducing the triassic conglomerate to the north of the limestone as evidence of this theory.

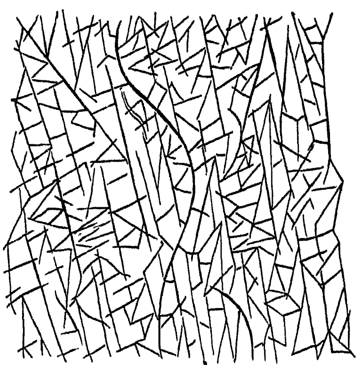
The writer has devoted some time to the study of this interesting region, and, with the able assistance of Mr. S. E. Paschall, of Doylestown, Mr. John S. Ash, of Holicong, and others, has prepared a map of the area, and has been able to trace for a distance of nearly twenty miles an important fault, which has not only thrown up the whole thickness of the Trias, exposing its basal conglomerate, but has brought to the surface its floor of Palæozoic rocks.

The fault has a length of about nineteen and a half miles. Its extreme western limit is near the point where the Neshaminy crosses the line between Bucks and Montgomery counties, about four miles west of Chalfont. (Chalfont is called Whitehallville on the maps.) The line of fault is not visible in Montgomery county, and its western terminus is in close proximity to, and probably in actual contact with a horizon of blackened shales, extending thence in a north-easterly direction, and almost continuously, across Bucks county to the great region of black shales (quarried for curbing stones) about Point Pleasant, on the Delaware river.

The line of fault is marked by abnormal dips, blackened and broken shales, "slickensides," and other evidences of violent disturbance, along its whole length. But its most characteristic feature is the occurrence of a zone of typical "*fault rock.*" This very interesting feature is composed of a mass of gray, shaly argillite, so crushed and cracked in every direction, and so baked and changed in character, that it has lost all traces of stratification. This peculiar rock, evidently the result of movement at the time of faulting, is cut by innumerable cleavage planes, crossing one another at every conceivable angle. The small and irregular angular blocks thus produced are very generally covered by slickensides, the result of sliding motion. This *fault-rock* marks the line of fault, when all other indications fail, and has rendered it possible to fix the precise position of the fault from end to end. It fills a zone one hundred feet or more in

width. The writer is not aware that such an extensive exposure of a fault-rock has been previously described. A few yards is usually given as the greatest width to which a fault-rock attains, although similar instances will doubtless be found elsewhere. The great development of this interesting formation along the Bucks County fault, leads to the conclusion that the process of faulting was a sudden event. The immense pressure, which gave rise to the fault, would appear to have been relieved by violent crushing and slipping, perhaps accompanied by earthquakes.

The best exposure of this fault-rock is in the railroad cut immediately east of Chalfont Station, on the Doylestown Branch of the Philadelphia and Reading Railroad—a locality which will well repay a visit. The accompanying sketch very rudely represents the appearance of the fault-rock at this place.



The principal cleavage planes are vertical or with a steep dip, while secondary cleavage planes cut in all directions. These principal cleavage planes are often curved and folded, as is finely illustrated on the Neshaminy creek between Bridge Point and Chalfont. Some interesting photographs were obtained of these contorted cleavage planes.

The fault-rock crosses the Neshaminy creek several times, and the course of that creek from Chalfont to Bridge Point appears to have been determined by the fault. At each place where the fault crosses the winding stream, an easily recognizable ledge of fault-rock appears, as for example near the boundary of New Britain, Doylestown and Warrington townships, or again near where the "State road" crosses the creek, or again west of Bridge Point.

The fault may be followed continuously across Bucks county in a curved line, concave towards the north, from the county line of Montgomery county to the Delaware. It passes through Chalfont and along the Neshaminy to Bridge Point, as already described, being shown in the stream at a point a mile above Godshalk's dam; also half a mile below Godshalk's dam, also just above Castle Valley bridge; also near Spruce hill; again near Bridge Point; thence, less distinctly to the hill below Bennett's corner, where limestone first appears immediately north of the fault, in the road-bed.

At Bushington, half a mile farther East, the limestone is conformably overlaid by Hudson River slates, on which the basal conglomerate of the Trias reposes unconformably. Upper Triassic red shales, dipping northeast, occur south of the line of fault. North-east of Bushington, hills of Potsdam sandstone rise from beneath the limestone to form "Buckingham

mountain," bounding "Buckingham valley" (of limestone) on the south. The fault runs immediately south of this Potsdam sandstone mountain, dividing it sharply from the upper Triassic red shales to the south, from a point near Bushington to the Delaware river below Limeport. All along its route, the characteristic signs of fault-rock may be detected by careful examination.

At "five points," on the "Street road," in the line between Buckingham and Solebury townships, a large mass of coarse-grained trap, known as Solebury mountain, abuts against the south side of the fault, while limestone is quarried north of the fault. Buckingham mountain dies down at this point, and the Potsdam sandstone from here to the river is either absent or represented only by fragments in the soil. The unusual feature of a trap mountain and a sandstone mountain abutting against one another and separated by a fault is exhibited at this point.

The fault passes "Ingham spring" and thence across the hills and through the woods to a point just below Limeport on the river, having been followed by the fragments of characteristic fault-rock lying on the surface. Mr. J. S. Ash, from a study of the position of springs in the vicinity, suggests that the line of fault is a water course, with vent at Ingham spring. This suggestion appears to be corroborated by an unsuccessful attempt recently made (May, 1885) to sink an artesian well a few hundred yards west of Chalfont Station, just south of the line of fault. The drill was sunk 160 feet, the workmen encountering two "boggy" places where black mud and broken stone hindered further operations.

On the New Jersey side of the Delaware, a great outburst of coarse grained diabase has apparently split the fault, since well-marked exposures of fault-rock occur both north and south of the eruptive trap. This trap extends into New Jersey only a mile or so, but beyond it, still extending in a north-east direction, is a horizon either of true fault-rock or of blackened shales, indicating a continuance of the fault. Professor Cook has noted the occurrence of north-east dips in the Triassic slates for many miles in the same direction.

These abnormal north-east dips of the Upper Triassic strata immediately south of the fault, seem to be due to the disturbance which produced the fault. As is well known, the usual dip of these strata is a gentle one to the north west. A large number of localities of abnormal dips were noted in Bucks county throughout the district south of the fault. Some examples may here be given. In Buckingham township, west of Forestville, some ringing, baked shales dip 30° E. 25° N.; near Worthington's store the dip is 30° $\pm$ E. 30° N.; at Carver's mill on Mill creek, three dips were taken successively going east, some ten feet apart, viz: 55° N. 30° E., N. 35° E., N. 40° E., indicating an anticlinal. Farther north-west there are flatter dips, but to the north-east there is again a steep dip to N. 30° E., and just east of Pineville the dip is vertical. Farther west, at Bridge valley on the old York road, some hardened, dark, ringing, fine-grained slaty strata, showing fine ripplemarks, dip 11° S. 70° E.; fifty feet farther south, the over-

lying red shales dip 10° E. 10° N. ; and twenty feet yet farther south the dip is 10° E. 15° N. Ripplemarks, fossil plants, and traces of coal in thin seams were here observed. Other localities farther west showed dips of 15° E. 10° N., the shales often being dark and resonant when struck. Near Bridge Point, on the south side of the fault, there is a dip of 15° E. 10° S. ; at Bridge Point some hard altered shales dip 30° E. 15° S. ; and some dips to the east were noticed south of Chalfont. Mr. S. E. Paschall reports that eastward dips continue in the strata south of the fault nearly to its western termination. North of the line of fault the normal north-western dip of 10° to 15° is resumed.

As already indicated, a blackening and induration of the triassic shales accompanies the abnormal dips south of the fault. Another zone of blackened shales crosses the county from Point Pleasant in a south-west direction north of the North branch of Neshaminy creek. There is an excellent exposure of this argillite near Point Pleasant, where it is largely developed and is quarried for curbing stone. It rings when struck by a hammer, and has a fine conchoidal fracture. The Indians used it for the manufacture of their stone implements, and traces of an ancient Indian workshop occur at Point Pleasant.

That the induration of these shales is due to the proximity of a trap dyke is a view often maintained, but the facts at command of the writer appear to point to a different explanation. The zones of blackened shales would seem to be coincident with lines of pressure and disturbance. Can it be that pressure alone would suffice to produce the change?

The fault and its accompanying phenomena having now been described, we may briefly consider the Palæozoic strata which it has elevated, before returning to the trap dyke displaced by it. A section across Buckingham valley, at its central point near Holicong, would show the following succession of strata, beginning at the fault: (1) Potsdam sandstone, forming Buckingham mountain, being identical with the Potsdam sandstone of the North Valley hill of Chester county, and dipping steeply N. W. ; (2) Magnesian limestone or calciferous sandrock (Cambrian), dipping steeply N. W., conformable with the Potsdam, and corresponding with the limestone on the northern side of Chester valley ; (3) Trenton limestone, slaty and fossiliferous, conformable with the last, and only differing from beds of the same age on the south side of Chester valley in being non-metamorphic. No beds of marble occur as in Chester valley, but on the other hand a number of characteristic Trenton fossils (trilobites, brachiopods and corals) occur in it ; (4) The basal breccia of the Trias lies unconformably on the last, and the junction is finely exposed on the farm of H. Shepherd, at Holicong. It is formed of limestone fragments cemented by red shale. It is common on the north side of the Triassic area in Pennsylvania (being identical with the so-called "Potomac marble"), but is rarely observed on the southern edge. The writer has also observed it south of Norristown on the Schuylkill Valley Railroad, where it exhibits a small but beautiful fault ; (5) A narrow stratum of red shale, containing

numerous calamites (*C. arenaceous*), overlies the breccia ; (6) The lower pebbly conglomerate of the Trias follows as a well-marked and definite horizon, which may be traced continuously from the Delaware at Centre bridge, past Spring valley, and south of Doylestown to the fault at Chalfont. It forms a ridge of pebbles and is readily recognized. The same horizon occurs at the southern edge of the Triassic area, extending from Norristown to Trenton ; (7) The long succession of red shales and sandstones which form the bulk of the Triassic strata follow on top of the conglomerate.

Had our section been made at Bushington, the Potsdam sandstone would have been absent, and Hudson River slates would have appeared conformably overlying the limestone, and unconformably overlaid by the Triassic conglomerate. These Hudson River slates are believed by the writer to correspond with the South Valley Hill slates and hydromica schists of Chester county, which latter have there been more highly metamorphosed. There is a striking similarity in their general appearance. From the observed dips of the limestone at the south-western end of Buckingham valley, there appears to exist here an anticlinal, by which the Potsdam sandstone is covered over, and the Hudson River slates swing around the end of the valley until they meet the fault. The fault is clearly a large and important one, of several thousand feet upthrow.

Returning now to the long trap dyke which we have followed from the south side of the Bucks county fault to the State of Maryland, it is interesting to find that at a point on the north side of the fault, nearly five miles west of the abrupt termination of the dyke near Bridge Point, another dyke of identical composition and structure as suddenly appears and extends for twenty miles in an arch, until it is again cut off by the fault. There is every indication that it is of the same age and origin as the long dyke previously described, and that it should be considered as part of it. The trap has the same characteristic weathered surfaces, the same metallic ring when struck, it forms the same narrow and often inconspicuous dyke, and hand specimens from the two dykes cannot be distinguished from one another, macroscopically or microscopically.

Starting north of Chalfont, between Pine run and the North branch of Neshaminy creek, in New Britain township, it curves north-eastward so as just to touch the corner of Doylestown and New Britain townships. It passes through the village of Iron Hill, so named on account of the numerous boulders of ringing trap which cover the hill. The dyke is here wider and more prominent than at any other place along this section. It passes thence about half a mile south-east of Gurden Glen Mills, whence, keeping immediately south of the North branch of the Neshaminy, it passes, one-third of a mile north of Fountainville, into Plumstead township. It is followed past Danborough, where it appears at the fork-roads north of the village ; past Gardenville, crossing the road a quarter of a mile north of the village ; whence, curving towards the east, it enters Solebury township north of Carversville. The next village through which it passes is

Centre Hill, where it is clearly marked by numerous boulders. From here to the "Meeting House," near the fault, it was traced by Judge R. Watson of Doylestown, who reports it to be continuous, and Mr. Paschall states that it abuts against the fault.

This dyke is joined by another one, of entirely different structure, near Gardenville. This latter dyke, composed of a coarse-grained, almost granitic diabase, runs in a straight line from here to Point Pleasant, where it forms a large outburst and is finely exposed on the river bank. This dyke is here much wider and more massive than the long dyke which we have been following, and the diabase is not so hard nor so resonant. The decomposition products are also dissimilar. Yet both are true diabases, differing mainly in their degree of coarseness, and, as the following analyses show, of very similiar composition. Dr. F. A. Genth* has analyzed the diabase at Point Pleasant, and Mr. F. A. Genth, Jr., has analyzed that from Gulf Mills, Upper Merion township, Montgomery county. The latter is typical of the diabase of the long dyke. Analysis No. I is of the Point Pleasant diabase, No. II of the Gulf Mills diabase.

	(I)	(II)
Loss by ignition	0.29	2.15
Silicic acid	52.91	51.56
Titanic acid	1.03	1.63
Phosphoric acid	0.12	0.13
Alumina	14.45	17.38
Ferric oxide	6.42	6.57
Ferrous oxide	4.38	3.85
Magnesia	8.34	3.42
Lime	9.92	10.19
Lithia	—	trace.
Soda	1.80	2.19
Potash	0.57	1.46
	100.23	100.53

Of similar structure are two other large outbursts of trap which form "Solebury mountain" and "Jericho hill" in Solebury and Upper Makefield townships respectively. These, like the Point Pleasant dyke, appear to have no connection with the long narrow dyke which, with its continuation north of the great fault, forms the subject of this paper. They are composed of a light colored, coarse-grained diabase, crumbling when decomposed, and quite unlike the dense dark rock of the long dyke. These dykes have the curved shape so often seen in the ordinary Triassic dykes, of which those in the Connecticut valley may be taken as types.

While our long dyke represents a simple crack in the earth's crust, the strata on either side being unaltered, these crescentic dykes are accompanied by disturbances in the surrounding strata. Thus the Triassic shales

* Report C^6, p. 184.

are more or less conformable to the outcrop of the Jericho Hill dyke, changing in dip as the outcrop of the dyke varies in direction. As examples of Triassic shales dipping away from the concave side of Jericho hill, the following dips, observed by the writer in Upper Makefield township, may be recorded. Immediately north of the western end of the dyke, the red shales dip 15° S. 40° W. and, one hundred feet away, 32° S. 35° W., the latter on the farm of A. Smith. On the border of Upper Makefield and Solebury townships, near Pidcocks creek, somewhat over a mile west of the eastern horn of the dyke, dips of 22° N. 45° W., and 25° N. 30° W., were observed.

It appears therefore that the crescentic shape of Jericho hill is coincident with a flat anticlinal fold in the Trias, the axis of the fold dipping westward. But if this is the case, the conclusion is probable that the trap is an overflow sheet, overlaid and underlaid by shales, which, with the intercalated trap, have been subsequently folded. The crescent form of the outcrop of the trap would be the natural result of the erosion of a westward dipping flat anticlinal fold.* These crescentic dykes would thus be of inter-Triassic age, and therefore older than the long dyke across the State.

Another short narrow dyke, which cuts through the limestone in D. Ely's quarry in Solebury township, is noted in the accompanying map, but it has no connection with and is of different composition from the long dyke.

The two dykes with which this paper especially deals, viz: that extending from the Maryland border to the Bucks County fault, and that extending from Chalfont to the fault again, constitute, whether we consider them as one dyke displaced, or as two dykes separated by a fault of contemporaneous age, a feature of considerable geological interest. They clearly represent, as has been seen, a great crack, due to separation of the strata, being precisely the reverse of the action which produced the fault, where evidences of pressure abound. No facts were observed which demonstrate that the crack occupied by the trap was a line of fault. On the other hand, we have seen that where an unmistakable fault cuts off the dyke, such fault has not been entered by the trap. The fault was filled by a compact mass of its own rubbish—the "fault-rock."

An examination of the relations between the Bucks County fault and the trap dyke divided by it, renders it probable that they are of contemporaneous Jurassic age. A mere inspection of the accompanying map leads to the conviction that the bow-shaped dyke north of Buckingham valley is due to the filling by trap of a crack caused by the uptilting of the Palæozoic and Triassic strata at the time of the great fault. It is just as if a cake of ice on a pond had been forced up at one side, at the same time

* The relations between crescentic Triassic trap dykes and the adjoining strata and the distinctions between intrusive and overflow dykes have recently been discussed by Mr. W. M. Davis in a paper on Triassic Trap Dykes and Sandstones (Bull. Mus. Comp. Zool. ix).

cracking on the other, and letting the water ooze through the narrow crack. The line of fault itself was subject to such pressure as to prevent the entrance of the trap, except perhaps on the New Jersey side of the river, where, as we have shown, the trap seems to have burst through from below.

The Jurassic age of the dyke and fault is indicated by the fact that while cutting through the uppermost Triassic strata, similar dykes and faults in New Jersey are unconformably covered by strata of lower Cretaceous age. It follows that the "jogs" in the trap dyke, and also probably in the line of serpentine outcrops in Chester county, may be faults of so recent an age as the Jurassic. The relation between the dyke and the faults of the same region is an interesting one, and may hereafter throw some light on the complicated geology of Southeastern Pennsylvania.*

*Perhaps it is well here to notice briefly an article by Dr. P. Frazer relating to the dyke just described. An abstract of the present paper, omitting details, was given verbally at the meeting of the American Association for the Advancement of Science, in September last. Since then, without waiting for the publication of the paper, Dr. P. Frazer, who was entrusted with the survey of Chester county and who had omitted to notice the trap dyke, soon afterwards printed a reply entitled, "Trap dykes in the Archæan rocks of S. E. Pennsylvania" (Proc. Amer. Philos. Soc. Oct. 17, 1884), in which he endeavors to show, firstly, that there is *no* continuous dyke across the region which he has studied, and secondly, that *if* such a dyke exists it marks a fault which he had established long ago. He concludes by denying that the trap is of uniform composition.

The title of Dr. Frazer's paper is unfortunate, since but an extremely small proportion of the metamorphic area traversed by the dyke belongs to the Archæan rocks, properly so called. He is also unfortunate in giving the excuse for the premature publication of his paper that "error is notoriously fleet of foot, and with a year's start may defy pursuit," before establishing that any error existed. Had Dr. Frazer been aware of the details now first made known, he would hardly have ventured to deny the essential continuity of the dyke in Chester county. Nor is he accurate in supposing that the dyke marks the fault which he assumed to exist in that county. His supposed fault, not yet demonstrated to be a fact, passed along the north side of the South Valley hill, while the dyke is south of that area. His final statement that "there were strongly marked differences of texture, structure and constitution between many of the outcrops south of the Chester valley and near Conshohocken" is unsupported by any facts brought forward by himself, and is directly opposed to the microscopical examinations made by the present writer, which show a remarkable uniformity in each of these particulars. Dr. Frazer has evidently mistaken other eruptive rocks for the diabase of which the long dyke is composed.

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[* Accepted. † Took his seat.]

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